Service Manual

Groundsmaster® 3505–D

Preface

The purpose of this publication is to provide the service technician with information for troubleshooting, testing, and repair of major systems and components on the Groundsmaster 3505–D.

REFER TO THE OPERATOR'S MANUAL FOR OPERATING, MAINTENANCE AND ADJUSTMENT INSTRUCTIONS. For reference, insert a copy of the Operator's Manual and Parts Catalog for your machine into Chapter 2 of this service manual. Additional copies of the Operator's Manual and Parts Catalog are available on the internet at www.Toro.com.

The Toro Company reserves the right to change product specifications or this publication without notice.

This safety symbol means DANGER, WARNING or CAUTION, PERSONAL SAFETY INSTRUCTION. When you see this symbol, carefully read the instructions that follow. Failure to obey the instructions may result in personal injury.

NOTE: A **NOTE** will give general information about the correct operation, maintenance, service, testing or repair of the machine.

IMPORTANT: The IMPORTANT notice will give important instructions which must be followed to prevent damage to systems or components on the machine.

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Chapter 1

Safety

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General Safety Instructions

The GROUNDSMASTER 3505–D was tested and certified by TORO for compliance with existing standards and specifications as identified in the Operator's Manual. Although hazard control and accident prevention are dependent partially upon the design and configuration of the machine, these factors are also dependent upon the awareness, concern and proper training of the personnel involved in the operation, transport, maintenance and storage of the machine. Improper use or maintenance by the operator or owner of the machine can result in injury. To reduce the potential for any injury, comply with the following safety instructions.

WARNING

To reduce the potential for injury or death, comply with the following safety instructions.

Supervisor's Responsibilities

1. Make sure operators are thoroughly trained and familiar with the Operator's Manual, Operator's Video and all the operating and safety decals on the machine.

2. Be sure to establish your own special procedures and work rules for unusual operating conditions (e.g. slopes too steep for machine operation). **Survey mowing site completely to determine which hills can be operated on safely.** When performing this site survey, always use common sense and take into consideration the turf condition and the rollover risk. To perform a site survey, follow the procedure outlined in the Traction Unit Operator's Manual. **THE MAXIMUM SIDE HILL ANGLE SHOULD NOT BE GREATER THAN 15 DEGREES.**

Before Operating

1. Read and understand the contents of the Operator's Manual before starting and operating the machine. Become familiar with the controls and know how to stop the machine and engine quickly. Copies of the Operator's Manual are available on the internet at www.Toro.com.

2. Keep all shields, safety devices and decals in place. If a shield, safety device or decal is defective, illegible or damaged, repair or replace it before operating the machine. Also tighten any loose nuts, bolts or screws to ensure machine is in safe operating condition.

3. Assure that operator's presence controls, safety switches and shields are attached and functioning properly. Do not operate the machine unless these items are functioning properly.

4. Since fuel is highly flammable, handle it carefully:

   A. Store fuel in containers specifically designed for this purpose.

   B. Do not remove machine fuel tank cap while engine is hot or running.

   C. Do not smoke while handling fuel.

   D. Fill fuel tank outdoors and only to within an inch of the top of the tank, not the filler neck. Do not overfill.

   E. Replace fuel tank and fuel container caps securely after refueling machine.

   F. If fuel is spilled, do not attempt to start the engine but move the machine away from the area of the spillage. Avoid creating any source of ignition until fuel vapors have dissipated. Clean up any spilled fuel.

While Operating

1. Sit on the seat when starting and operating the machine.

2. Before starting the engine:

   A. Engage the parking brake.

   B. Make sure traction pedal is in neutral and the P.T.O. switch is OFF (disengaged).

   C. After engine is started, release parking brake and keep foot off traction pedal. Machine must not move. If movement is evident, the traction pedal linkage is adjusted incorrectly; therefore, shut engine off and adjust traction pedal linkage until machine does not move when traction pedal is released (see Traction Unit Operator's Manual).

3. Do not run engine in a confined area without adequate ventilation. Exhaust fumes are hazardous and could possibly be deadly.

4. The slope angle at which the machine will tip is dependent on many factors. Among these are mowing conditions such as wet or undulating turf, speed (especially in turns), tire pressure and operator experience. At side hill angles of 10 degrees or less, the risk of a rollover is low. As the slope angle increases to a recommended maximum limit of 15 degrees, the risk of a rollover increases to a moderate level. **DO NOT EXCEED A 15 DEGREE SIDE HILL ANGLE BECAUSE THE RISK OF A ROLLOVER AND SERIOUS INJURY OR DEATH IS VERY HIGH.**

5. Do not touch engine, radiator or exhaust system while engine is running or soon after it is stopped. These areas could be hot enough to cause burns.

6. Before getting off the seat:

   A. Ensure that traction pedal is in neutral.

   B. Lower and disengage cutting decks and wait for all movement to stop.

   C. Set parking brake.

   D. Stop engine and remove key from ignition switch.

7. Anytime the machine is parked (short or long term), the cutting decks should be lowered to the ground. This relieves pressure from the lift circuit and eliminates the risk of a cutting deck accidentally lowering to the ground.

8. Do not park on slopes unless wheels are chocked or blocked.

Maintenance and Service

1. Before servicing or making adjustments, lower cutting decks, stop engine, set parking brake and remove key from the switch.

2. Make sure machine is in safe operating condition by keeping all nuts, bolts and screws tight.

3. Never store the machine or fuel container inside where there is an open flame, such as near a water heater or furnace.

4. Make sure all hydraulic line connectors are tight, and all hydraulic hoses and lines are in good condition before applying pressure to the hydraulic system.

5. Keep body and hands away from pin hole leaks in hydraulic lines that eject high pressure hydraulic fluid. Use cardboard or paper to find hydraulic leaks. Hydraulic fluid escaping under pressure can penetrate skin and cause injury. Fluid accidentally injected into the skin must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.

6. Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved by lowering the cutting decks to the ground, stopping the engine and then using all of the hydraulic controls (depressing the traction pedal, turning the steering wheel in both directions and energizing the deck solenoid with the engine not running).

7. If major repairs are ever needed or assistance is desired, contact an Authorized Toro Distributor.

8. Use care when checking or servicing the cutting deck. Wear gloves and use caution when servicing it.

9. To reduce potential fire hazard, keep engine area free of excessive grease, grass, leaves and dirt. Clean protective screen on machine frequently.

10. If engine must be running to perform maintenance or to make an adjustment, keep hands, feet, clothing and other parts of the body away from the cutting decks and other moving parts. Keep bystanders away.

11. Do not overspeed the engine by changing governor setting. To assure safety and accuracy, check maximum engine speed with a tachometer.

12. Shut engine off before checking or adding oil to the crankcase.

13. Disconnect battery before servicing the machine. Disconnect negative battery cable first and positive cable last. If battery voltage is required for troubleshooting or test procedures, temporarily connect the battery. Reconnect positive cable first and negative cable last.

14. Battery acid is poisonous and can cause burns. Avoid contact with skin, eyes and clothing. Protect your face, eyes and clothing when working with a battery.

15. Battery gases can explode. Keep cigarettes, sparks and flames away from the battery.

16. If welding on the machine is necessary, disconnect the negative battery cable to prevent electrical system damage.

17. At the time of manufacture, the machine conformed to the safety standards for riding mowers. To assure optimum performance and continued safety certification of the machine, use genuine Toro replacement parts and accessories. Replacement parts and accessories made by other manufacturers may result in non-conformance with the safety standards, and the warranty may be voided.

18. When changing attachments, tires or performing other service, use correct blocks, hoists and jacks. Make sure machine is parked on a solid level floor such as a concrete floor. Prior to raising the machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands or solid wood blocks to support the raised machine. If the machine is not properly supported by blocks or jack stands, the machine may move or fall, which may result in personal injury (see Jacking Instructions in this chapter).

Jacking Instructions

CAUTION

When changing attachments, tires or performing other service, use correct blocks, hoists and jacks. Make sure machine is parked on a solid level floor such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands or solid wood blocks to support the raised machine. If the machine is not properly supported by blocks or jack stands, the machine may move or fall, which may result in personal injury.

Jacking the Front End

1. If the front wheel motor is to be removed, position jack securely under the square tube of the lower frame as closely to the side plate as possible (Fig. 1).

2. If the front tire is to be removed, position the jack securely under the front wheel motor.

3. Use jack stands or hardwood blocks under the square tube or wheel motors to support the machine.

Jacking the Rear End

1. The preferred method for removing the rear fork or the rear wheel is to lift the rear end of the machine from above:

   A. Secure a chain fall or hoist to the rear casting (Fig 2).

   B. Chock both front tires. Lift rear tire off the ground.

   C. Use jack stands or hardwood blocks under the frame to support the machine (Fig. 3).

2. If the rear of the machine cannot be lifted from above:

   A. Chock both front tires.

   IMPORTANT: Make sure jack is as close to the rear fork as possible when jacking the machine.

   B. Place jack securely under the rear casting as close to the fork as possible (Fig. 3). Jack rear tire off the ground.

   C. Use jack stands or blocks under the frame to support the machine.

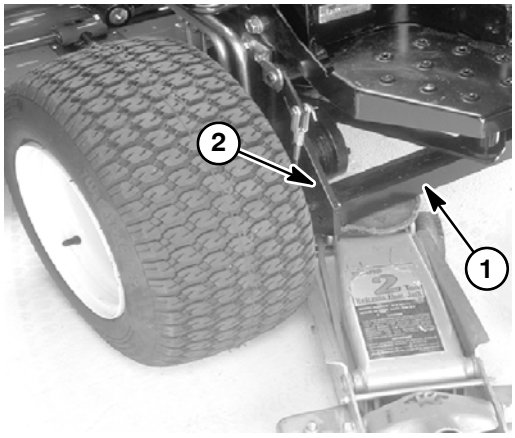

Figure 1

1. **Square tube**
2. **Side plate**

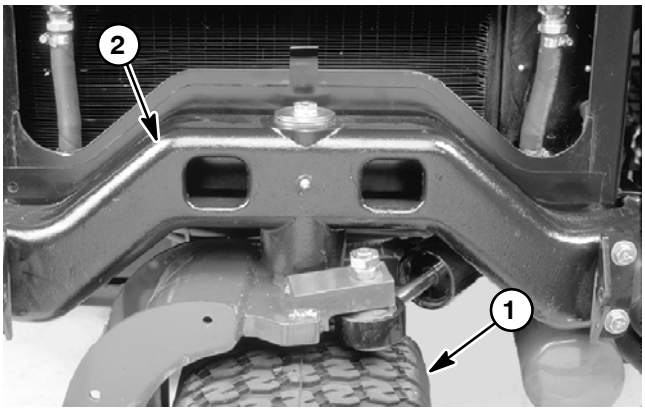

Figure 2

1. **Rear tire**
2. **Rear casting**

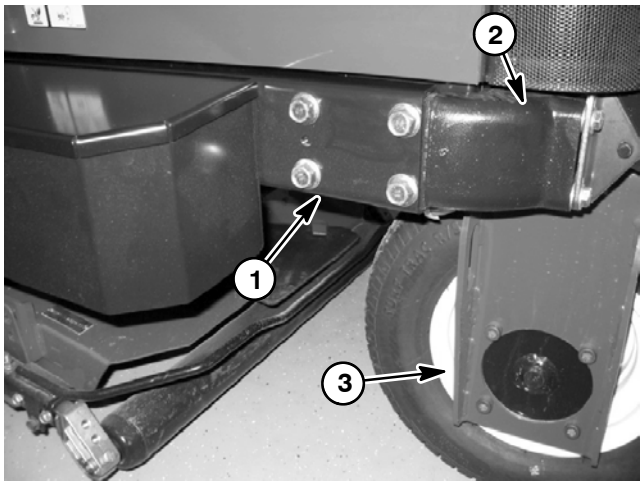

Figure 3

1. **Frame**
2. **Rear casting**
3. **Rear fork**

Chapter 2

Product Records and Maintenance

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Product Records

Insert a copy of the Operator's Manual and Parts Catalog for your Groundsmaster 3505–D at the end of this chapter. Additionally, if any optional equipment or accessories have been installed to your Groundsmaster, insert the Installation Instructions, Operator's Manuals and Parts Catalogs for those options at the end of this chapter.

Maintenance

Maintenance procedures and recommended service intervals for the Groundsmaster 3505–D are covered in the Operator's Manual. Refer to that publication when performing regular equipment maintenance.

Equivalents and Conversions

Decimal and Millimeter Equivalents

Fractions	Decimals	mm	Fractions	Decimals	mm
1/64	0.015625	— 0.397	33/64	0.515625	— 13.097
1/32	0.03125	— 0.794	17/32	0.53125	— 13.494
3/64	0.046875	— 1.191	35/64	0.546875	— 13.891
1/16	0.0625	— 1.588	9/16	0.5625	— 14.288
5/64	0.078125	— 1.984	37/64	0.578125	— 14.684
3/32	0.09375	— 2.381	19/32	0.59375	— 15.081
7/64	0.109275	— 2.778	39/64	0.609375	— 15.478
1/8	0.1250	— 3.175	**5/8**	0.6250	— 15.875
9/64	0.140625	— 3.572	41/64	0.640625	— 16.272
5/32	0.15625	— 3.969	21/32	0.65625	— 16.669
11/64	0.171875	— 4.366	43/64	0.671875	— 17.066
3/16	0.1875	— 4.762	11/16	0.6875	— 17.462
13/64	0.203125	— 5.159	45/64	0.703125	— 17.859
7/32	0.21875	— 5.556	23/32	0.71875	— 18.256
15/64	0.234375	— 5.953	47/64	0.734375	— 18.653
1/4	0.2500	— 6.350	**3/4**	0.7500	— 19.050
17/64	0.265625	— 6.747	49/64	0.765625	— 19.447
9/32	0.28125	— 7.144	25/32	0.78125	— 19.844
19/64	0.296875	— 7.541	51/64	0.796875	— 20.241
5/16	0.3125	— 7.938	13/16	0.8125	— 20.638
21/64	0.328125	— 8.334	53/64	0.828125	— 21.034
11/32	0.34375	— 8.731	27/32	0.84375	— 21.431
23/64	0.359375	— 9.128	55/64	0.859375	— 21.828
3/8	0.3750	— 9.525	**7/8**	0.8750	— 22.225
25/64	0.390625	— 9.922	57/64	0.890625	— 22.622
13/32	0.40625	— 10.319	29/32	0.90625	— 23.019
27/64	0.421875	— 10.716	59/64	0.921875	— 23.416
7/16	0.4375	— 11.112	15/16	0.9375	— 23.812
29/64	0.453125	— 11.509	61/64	0.953125	— 24.209
15/32	0.46875	— 11.906	31/32	0.96875	— 24.606
31/64	0.484375	— 12.303	63/64	0.984375	— 25.003
1/2	0.5000	— 12.700	**1**	1.000	— 25.400

1 mm = 0.03937 in. **0.001 in. = 0.0254 mm**

U.S.to Metric Conversions

	To Convert	Into	Multiply By
Linear Measurement	Miles	Kilometers	1.609
	Yards	Meters	0.9144
	Feet	Meters	0.3048
	Feet	Centimeters	30.48
	Inches	Meters	0.0254
	Inches	Centimeters	2.54
	Inches	Millimeters	25.4
Area	Square Miles	Square Kilometers	2.59
	Square Feet	Square Meters	0.0929
	Square Inches	Square Centimeters	6.452
	Acre	Hectare	0.4047
Volume	Cubic Yards	Cubic Meters	0.7646
	Cubic Feet	Cubic Meters	0.02832
	Cubic Inches	Cubic Centimeters	16.39
Weight	Tons (Short)	Metric Tons	0.9078
	Pounds	Kilograms	0.4536
	Ounces (Avdp.)	Grams	28.3495
Pressure	Pounds/Sq. In.	Kilopascal	6.895
	Pounds/Sq. In.	Bar	0.069
Work	Foot-pounds	Newton-Meters	1.356
	Foot-pounds	Kilogram-Meters	0.1383
	Inch-pounds	Kilogram-Centimeters	1.152144
Liquid Volume	Quarts	Liters	0.9463
	Gallons	Liters	3.785
Liquid Flow	Gallons/Minute	Liters/Minute	3.785
Temperature	Fahrenheit	Celsius	1. Subract 32° 2. Multiply by 5/9

Torque Specifications

Recommended fastener torque values are listed in the following tables. For critical applications, as determined by Toro, either the recommended torque or a torque that is unique to the application is clearly identified and specified in this Service Manual.

These Torque Specifications for the installation and tightening of fasteners shall apply to all fasteners which do not have a specific requirement identified in this Service Manual. The following factors should be considered when applying torque: cleanliness of the fastener, use of a thread sealant (e.g. Loctite), degree of lubrication on the fastener, presence of a prevailing torque feature (e.g. Nylock nut), hardness of the surface underneath the fastener's head or similar condition which affects the installation.

As noted in the following tables, torque values should be **reduced by 25% for lubricated fasteners** to achieve the similar stress as a dry fastener. Torque values may also have to be reduced when the fastener is threaded into aluminum or brass. The specific torque value should be determined based on the aluminum or brass material strength, fastener size, length of thread engagement, etc.

The standard method of verifying torque shall be performed by marking a line on the fastener (head or nut) and mating part, then back off fastener 1/4 of a turn. Measure the torque required to tighten the fastener until the lines match up.

Fastener Identification

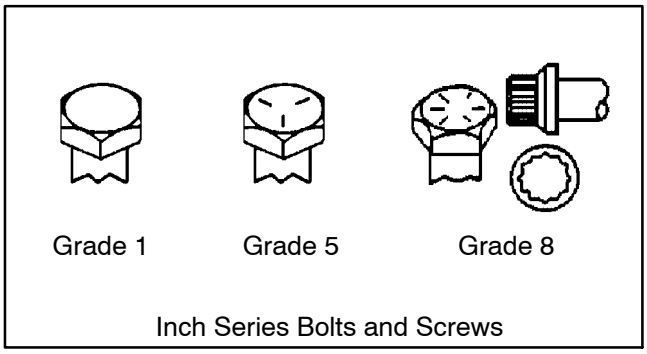

Figure 1

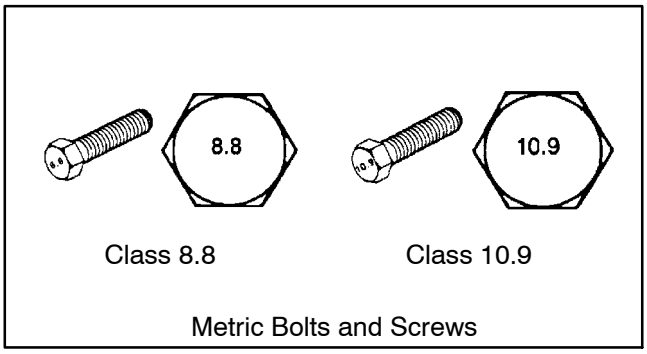

Figure 2

Standard Torque for Dry, Zinc Plated and Steel Fasteners (Inch Series)

Thread Size	Grade 1, 5 & 8 with Thin Height Nuts	SAE Grade 1 Bolts, Screws, Studs & Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 5 Bolts, Screws, Studs & Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 8 Bolts, Screws, Studs & Sems with Regular Height Nuts (SAE J995 Grade 5 or Stronger Nuts)	
	in-lb	**in-lb**	**N-cm**	**in-lb**	**N-cm**	**in-lb**	**N-cm**
# 6 - 32 UNC	10 ± 2	13 ± 2	147 ± 23	15 ± 2	169 ± 23	23 ± 3	262 ± 34
# 6 - 40 UNF				17 ± 2	192 ± 23	25 ± 3	282 ± 34
# 8 - 32 UNC	13 ± 2	25 ± 5	282 ± 30	29 ± 3	328 ± 34	41 ± 5	463 ± 56
# 8 - 36 UNF				31 ± 4	350 ± 45	43 ± 5	486 ± 56
# 10 - 24 UNC	18 ± 2	30 ± 5	339 ± 56	42 ± 5	475 ± 56	60 ± 6	678 ± 68
# 10 - 32 UNF				48 ± 5	542 ± 56	68 ± 7	768 ± 79
1/4 - 20 UNC	48 ± 7	53 ± 7	599 ± 79	100 ± 10	1130 ± 113	140 ± 15	1582 ± 169
1/4 - 28 UNF	53 ± 7	65 ± 10	734 ± 113	115 ± 12	1299 ± 136	160 ± 17	1808 ± 192
5/16 - 18 UNC	115 ± 15	105 ± 15	1186 ± 169	200 ± 25	2260 ± 282	300 ± 30	3390 ± 339
5/16 - 24 UNF	138 ± 17	128 ± 17	1446 ± 192	225 ± 25	2542 ± 282	325 ± 33	3672 ± 373
	ft-lb	**ft-lb**	**N-m**	**ft-lb**	**N-m**	**ft-lb**	**N-m**
3/8 - 16 UNC	16 ± 2	16 ± 2	22 ± 3	30 ± 3	41 ± 4	43 ± 5	58 ± 7
3/8 - 24 UNF	17 ± 2	18 ± 2	24 ± 3	35 ± 4	47 ± 5	50 ± 6	68 ± 8
7/16 - 14 UNC	27 ± 3	27 ± 3	37 ± 4	50 ± 5	68 ± 7	70 ± 7	95 ± 9
7/16 - 20 UNF	29 ± 3	29 ± 3	39 ± 4	55 ± 6	75 ± 8	77 ± 8	104 ± 11
1/2 - 13 UNC	30 ± 3	48 ± 7	65 ± 9	75 ± 8	102 ± 11	105 ± 11	142 ± 15
1/2 - 20 UNF	32 ± 4	53 ± 7	72 ± 9	85 ± 9	115 ± 12	120 ± 12	163 ± 16
5/8 - 11 UNC	65 ± 10	88 ± 12	119 ± 16	150 ± 15	203 ± 20	210 ± 21	285 ± 28
5/8 - 18 UNF	75 ± 10	95 ± 15	129 ± 20	170 ± 18	230 ± 24	240 ± 24	325 ± 33
3/4 - 10 UNC	93 ± 12	140 ± 20	190 ± 27	265 ± 27	359 ± 37	375 ± 38	508 ± 52
3/4 - 16 UNF	115 ± 15	165 ± 25	224 ± 34	300 ± 30	407 ± 41	420 ± 43	569 ± 58
7/8 - 9 UNC	140 ± 20	225 ± 25	305 ± 34	430 ± 45	583 ± 61	600 ± 60	813 ± 81
7/8 - 14 UNF	155 ± 25	260 ± 30	353 ± 41	475 ± 48	644 ± 65	667 ± 66	904 ± 89

NOTE: Torque values may have to be reduced when installing fasteners into threaded aluminum or brass. The specific torque value should be determined based on the fastener size, the aluminum or base material strength, length of thread engagement, etc.

NOTE: The nominal torque values listed above for Grade 5 and 8 fasteners are based on 75% of the minimum proof load specified in SAE J429. The tolerance is approximately ± 10% of the nominal torque value. Thin height nuts include jam nuts.

NOTE: Reduce torque values listed in the table above by 25% for lubricated fasteners. Lubricated fasteners are defined as threads coated with a lubricant such as engine oil or thread sealant such as Loctite.

Standard Torque for Dry, Zinc Plated and Steel Fasteners (Metric Fasteners)

Thread Size	Class 8.8 Bolts, Screws and Studs with Regular Height Nuts (Class 8 or Stronger Nuts)		Class 10.9 Bolts, Screws and Studs with Regular Height Nuts (Class 10 or Stronger Nuts)	
M5 X 0.8	57 ± 6 in-lb	644 ± 68 N-cm	78 ± 8 in-lb	881 ± 90 N-cm
M6 X 1.0	96 ± 10 in-lb	1085 ± 113 N-cm	133 ± 14 in-lb	1503 ± 158 N-cm
M8 X 1.25	19 ± 2 ft-lb	26 ± 3 N-m	28 ± 3 ft-lb	38 ± 4 N-m
M10 X 1.5	38 ± 4 ft-lb	52 ± 5 N-m	54 ± 6 ft-lb	73 ± 8 N-m
M12 X 1.75	66 ± 7 ft-lb	90 ± 10 N-m	93 ± 10 ft-lb	126 ± 14 N-m
M16 X 2.0	166 ± 17 ft-lb	225 ± 23 N-m	229 ± 23 ft-lb	310 ± 31 N-m
M20 X 2.5	325 ± 33 ft-lb	440 ± 45 N-m	450 ± 46 ft-lb	610 ± 62 N-m

NOTE: Torque values may have to be reduced when installing fasteners into threaded aluminum or brass. The specific torque value should be determined based on the fastener size, the aluminum or base material strength, length of thread engagement, etc.

NOTE: The nominal torque values listed above are based on 75% of the minimum proof load specified in SAE J1199. The tolerance is approximately ± 10% of the nominal torque value.

NOTE: Reduce torque values listed in the table above by 25% for lubricated fasteners. Lubricated fasteners are defined as threads coated with a lubricant such as engine oil or thread sealant such as Loctite.

Other Torque Specifications

SAE Grade 8 Steel Set Screws

Thread Size	Recommended Torque	
	Square Head	Hex Socket
1/4 – 20 UNC	140 ± 20 in–lb	73 ± 12 in–lb
5/16 – 18 UNC	215 ± 35 in–lb	145 ± 20 in–lb
3/8 – 16 UNC	35 ± 10 ft–lb	18 ± 3 ft–lb
1/2 – 13 UNC	75 ± 15 ft–lb	50 ± 10 ft–lb

Wheel Bolts and Lug Nuts

Thread Size	Recommended Torque**	
7/16 – 20 UNF Grade 5	65 ± 10 ft–lb	88 ± 14 N–m
1/2 – 20 UNF Grade 5	80 ± 10 ft–lb	108 ± 14 N–m
M12 X 1.25 Class 8.8	80 ± 10 ft–lb	108 ± 14 N–m
M12 X 1.5 Class 8.8	80 ± 10 ft–lb	108 ± 14 N–m

** For steel wheels and non–lubricated fasteners.

Thread Cutting Screws (Zinc Plated Steel)

Type 1, Type 23 or Type F	
Thread Size	**Baseline Torque***
No. 6 – 32 UNC	20 ± 5 in–lb
No. 8 – 32 UNC	30 ± 5 in–lb
No. 10 – 24 UNC	38 ± 7 in–lb
1/4 – 20 UNC	85 ± 15 in–lb
5/16 – 18 UNC	110 ± 20 in–lb
3/8 – 16 UNC	200 ± 100 in–lb

Thread Cutting Screws (Zinc Plated Steel)

Thread Size	Threads per Inch		Baseline Torque*
	Type A	Type B	
No. 6	18	20	20 ± 5 in–lb
No. 8	15	18	30 ± 5 in–lb
No. 10	12	16	38 ± 7 in–lb
No. 12	11	14	85 ± 15 in–lb

* Hole size, material strength, material thickness & finish must be considered when determining specific torque values. All torque values are based on non–lubricated fasteners.

Conversion Factors

in–lb X 11.2985 = N–cm
ft–lb X 1.3558 = N–m

N–cm X 0.08851 = in–lb
N–m X 0.7376 = ft–lb

Chapter 3

Kubota Diesel Engine

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KUBOTA WORKSHOP MANUAL, DIESEL ENGINE, 05 SERIES

Introduction

This Chapter gives information about specifications, troubleshooting, testing and repair of the Kubota D1105T diesel engine used in the Groundsmaster 3505–D. Refer to the Traction Unit Operator's Manual for engine maintenance information.

Most repairs and adjustments require tools which are commonly available in many service shops. Special tools are described in the Kubota Workshop Manual, Diesel Engine, 05 Series included at the end of this chapter. The use of some specialized test equipment is explained. However, the cost of the test equipment and the specialized nature of some repairs may dictate that the work be done at an engine repair facility.

Service and repair parts for Kubota engines are supplied through your Authorized Toro Distributor. If no parts list is available, be prepared to provide your distributor with the Toro equipment model and serial numbers as well as the Kubota engine model and serial numbers.

Specifications

Item	Description
Make / Designation	Kubota D1105T, 3 Cylinder, Liquid Cooled, Turbocharged, Diesel Engine
Horse Power	32 HP @ 2800 RPM
Bore mm (in.)	78.0 (3.07)
Stroke mm (in.)	78.4 (3.09)
Total Displacement cc (cu. in.)	1123 (68.53)
Firing Order	1-2-3
Combustion Chamber	Spherical Type
Fuel	No. 2 Diesel Fuel (ASTM D975)
Fuel Capacity liters (gallons)	41.6 (11)
Fuel Injection Pump	Bosch MD Type Mini Pump
Governor	Centrifugal Mechanical
Low Idle (no load)	1400 $\pm$ 50 RPM
High Idle (no load)	3050 $\pm$ 50 RPM
Direction of Rotation	Counterclockwise (Viewed from Flywheel)
Compression Ratio	23:1
Injection Nozzles	Mini Nozzle (DNOPD)
Engine Oil	See Traction Unit Operator's Manual
Oil Pump	Trochoid Type
Crankcase Oil Capacity liters (U.S. qt.)	3.8 (4.0) with Filter
Starter	12 VDC, 1.4 KW
Alternator/Regulator	12 VDC, 40 AMP
Dry Weight kilograms (U.S. lbs)	98.0 (216.0)
Coolant Capacity liters (U.S. qt.)	5.7 (6.0) with 0.9 (1.0) Reservoir

Muffler and Air Cleaner Assembly

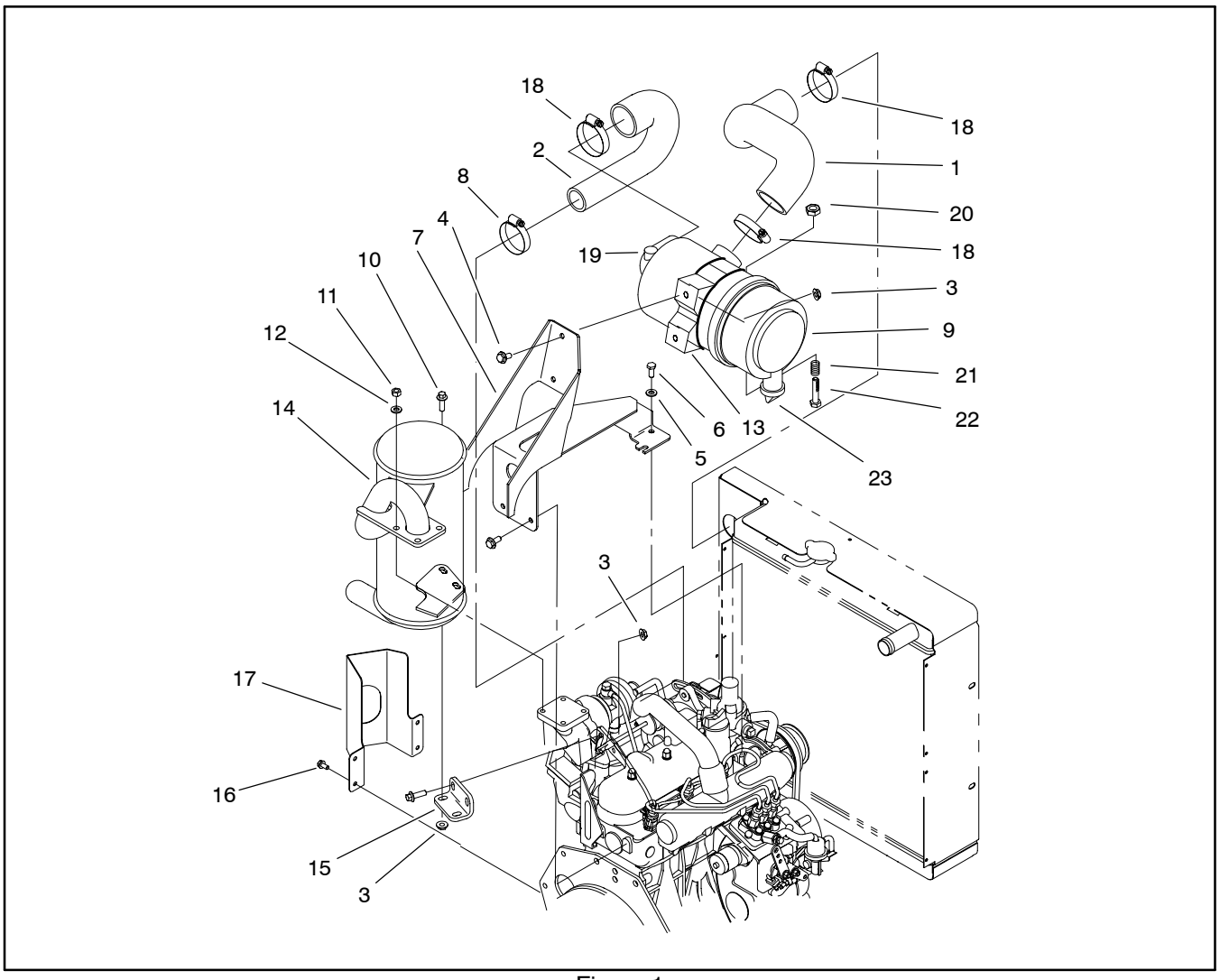

Figure 1

1. Air inlet hose (upper)
2. Air inlet hose (lower)
3. Flange nut
4. Flange head screw
5. Flat washer
6. Cap screw
7. Air filter mount
8. Hose clamp
9. Air cleaner assembly
10. Flange head screw
11. Hex nut (4 used)
12. Lock washer (4 used)
13. Mounting band assembly
14. Muffler
15. Muffler bracket
16. Cap screw (4 used)
17. Exhaust guard (if used)
18. Hose clamp
19. Plug
20. Lock nut
21. Compression spring
22. Bolt
23. Vacuator valve

Muffler Removal (Fig. 1)

CAUTION

The muffler and exhaust pipe may be hot. To avoid possible burns, allow the engine and exhaust system to cool before working on the muffler.

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. Open hood to gain access to engine.

3. Remove exhaust guard (if equipped) from frame.

4. Remove both flange head nuts and screws securing the muffler plate to the muffler bracket (Fig. 2).

5. Remove four hex nuts and lock washers from the exhaust manifold studs. Separate muffler flange from the exhaust manifold. Remove muffler from the machine.

6. Remove exhaust gasket. Replace gasket if damaged or torn.

Muffler Installation (Fig. 1)

NOTE: Make sure muffler flange and exhaust manifold sealing surfaces are free of debris or damage that may prevent a tight seal.

1. Place exhaust gasket on the exhaust manifold.

IMPORTANT: Finger tighten all fasteners before securing the muffler plate to the muffler bracket so there is no preload on the exhaust manifold.

2. Position muffler flange to the exhaust manifold with four lock washers and hex nuts.

3. Position muffler plate to the muffler bracket with both flange head screws and nuts (Fig. 2).

4. Tighten muffler flange hex nuts and then muffler plate screws and nuts.

5. If equipped, install exhaust guard to frame.

6. Close and latch hood.

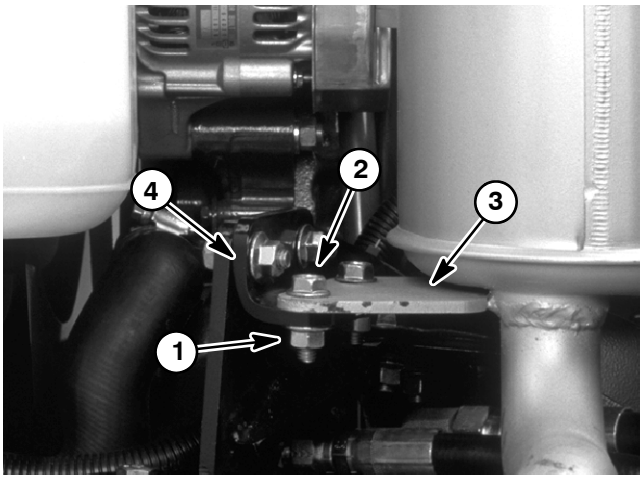

Figure 2

1. **Flange head nut**
2. **Flange head screw**
3. **Muffler plate**
4. **Muffler bracket**

Air Cleaner Assembly Removal (Fig. 1)

NOTE: See Traction Unit Operator's Manual for air cleaner maintenance procedures and intervals.

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch. Unlatch and raise hood.

2. Remove air cleaner components as needed using Figure 1 as a guide.

3. Check air cleaner body for damage that could cause possible air leaks. Make sure that dust cup seals completely to the air cleaner body.

Air Cleaner Assembly Installation (Fig. 1)

IMPORTANT: Any leaks in the air filter system will allow dirt into engine and will cause serious engine damage. Make sure that all air cleaner components are in good condition and are properly secured during assembly.

1. Assemble air cleaner system using Figure 1 as a guide. Make sure that vacuator valve is pointed down after assembly (Fig. 3).

2. Close and latch hood.

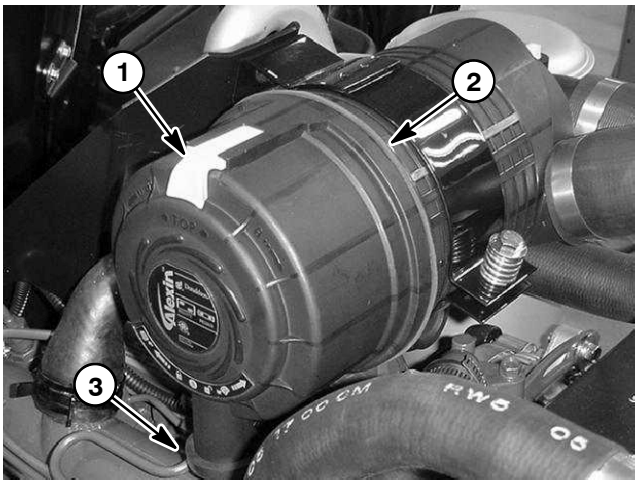

Figure 3

1. **Latch**
2. **Dust cup**
3. **Vacuator valve**

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Fuel System

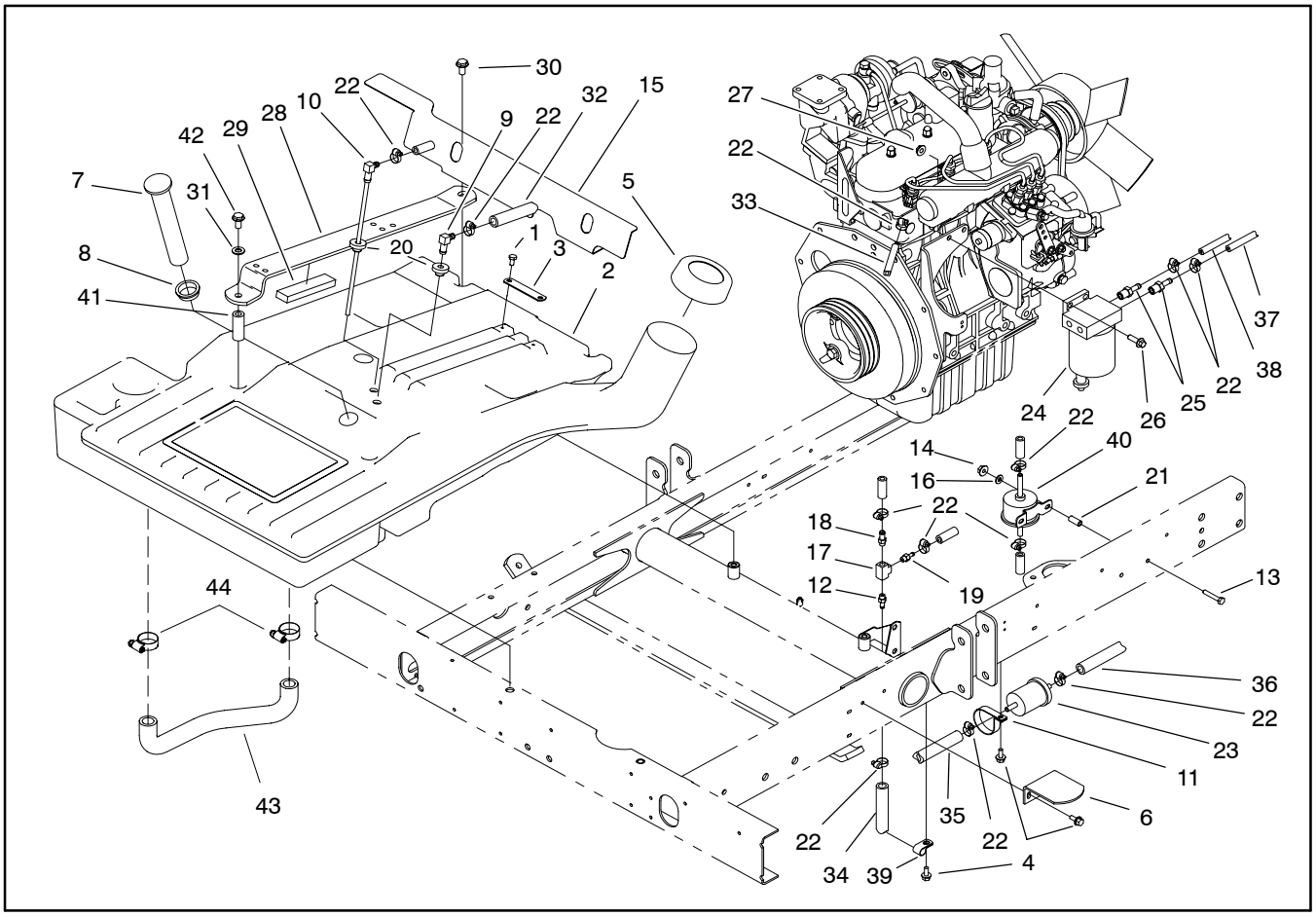

Figure 4

1. Cap screw (2 used)
2. Fuel tank
3. Fuel hose strap
4. Cap screw
5. Fuel cap
6. Tank support
7. Fuel gauge
8. Grommet
9. Connector fitting
10. Stand pipe
11. R-clamp
12. Barb fitting
13. Cap screw (2 used)
14. Flange hex nut (2 used)
15. Heat shield
16. Flat washer (2 used)
17. Tee fitting
18. Barb fitting
19. Barb fitting
20. Bushing
21. Spacer (2 used)
22. Hose clamp
23. Fuel prefilter
24. Fuel/water separator
25. Fuel fitting
26. Flange head screw (2 used)
27. Flange nut (2 used)
28. Seat support strap (2 used)
29. Foam (2 used)
30. Hex flange head screw (2 used)
31. Flat washer (2 used)
32. Fuel hose
33. Fuel hose
34. Fuel hose
35. Fuel hose
36. Fuel hose
37. Fuel hose
38. Fuel hose
39. R-clamp
40. Fuel pump
41. Spacer (2 used)
42. Cap screw (2 used)
43. Crossover fuel hose
44. Hose clamp

DANGER

Because diesel fuel is highly flammable, use caution when storing or handling it. Do not smoke while filling the fuel tank. Do not fill fuel tank while engine is running or hot or when machine is in an enclosed area. Always fill fuel tank outside and clean up any spilled diesel fuel before starting the engine. Store fuel in a clean, safety-approved container and keep cap in place. Use diesel fuel for the engine only; not for any other purpose.

Check Fuel Lines and Connections

Check fuel lines and connections every 400 hours or yearly, whichever comes first.

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch. Unlatch and raise hood.

2. Check fuel lines for deterioration, damage, leaks or loose connections. Replace hoses, clamps and connections as necessary.

Fuel Tank Removal (Fig. 4)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch. Unlatch and raise hood.

2. Remove fuel from the tank into a suitable container. Crossover fuel hose (item 44) removal may assist to drain tank completely.

3. Remove seat and seat support straps from the frame (see Operator Seat Removal in Chapter 6 – Chassis). Note location of spacers under front of seat support straps. Disconnect seat switch from the electrical harness (Fig. 5).

4. Remove fuel hose strap and both fuel hoses from the fuel tank. Pull tank from the machine (Fig. 5).

Drain and Clean Fuel Tank

Drain and clean the fuel tank every 2 years. Also, drain and clean the fuel tank if the fuel system becomes contaminated or if the machine is to be stored for an extended period.

1. Remove fuel tank from the machine (see Fuel Tank Removal).

2. Flush fuel tank out with clean diesel fuel. Make sure that tank is free of all contaminates and debris.

3. Install fuel tank to the machine (see Fuel Tank Installation).

Fuel Tank Installation (Fig. 4)

1. Position fuel tank to the machine.

2. Connect both fuel hoses to the tank and secure with hose clamps and fuel hose strap.

3. Connect seat switch to the electrical harness. Route seat switch wire under seat support strap. Secure seat support straps and seat to the frame (see Operator Seat Installation in Chapter 6 – Chassis).

4. Check for correct seat operation and also that seat switch wires and connector are not pinched and do not contact any moving parts.

5. Fill fuel tank (see Traction Unit Operator's Manual).

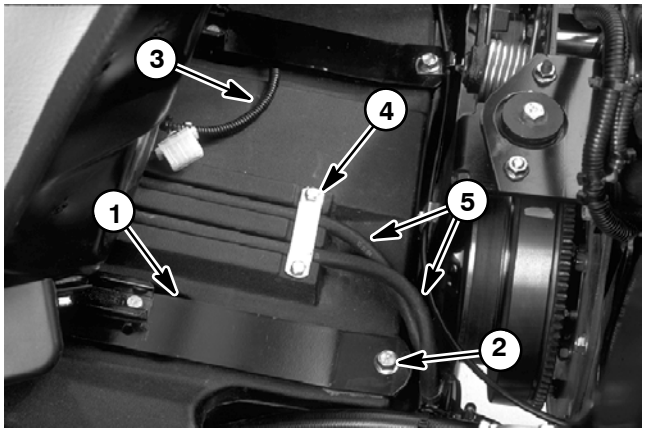

Figure 5

1. **Seat support strap**
2. **Hex flange head screw**
3. **Electrical harness**
4. **Fuel hose strap**
5. **Fuel hose**

Radiator

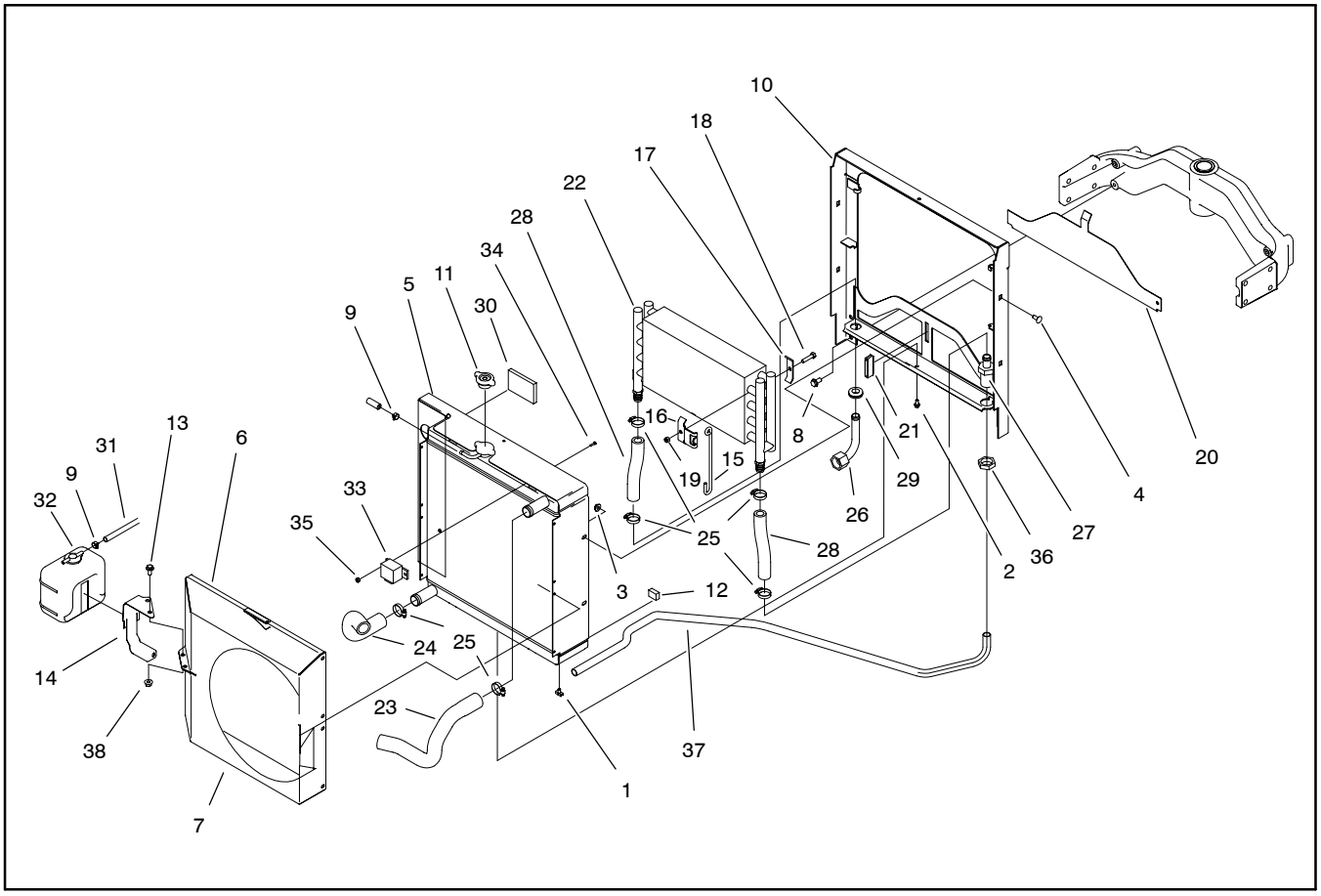

Figure 6

1. Draincock valve
2. Flange head screw (11 used)
3. Flange nut (4 used)
4. Carriage bolt (4 used)
5. Radiator
6. Upper fan shroud
7. Lower fan shroud
8. Flange head screw (4 used)
9. Hose clamp
10. Radiator frame
11. Radiator cap
12. Radiator foam seal
13. Flange head screw (2 used)
14. Reservoir bracket
15. Wire form latch (2 used)
16. Oil cooler bracket (2 used)
17. Bracket clamp (2 used)
18. Screw (2 used)
19. Lock nut (2 used)
20. Radiator shield (lower)
21. Magnetic catch
22. Oil cooler
23. Radiator hose (upper)
24. Radiator hose (lower)
25. Hose clamp
26. Hydraulic tube
27. Hydraulic tube
28. Oil cooler hose
29. Grommet
30. Foam seal
31. Expansion tank hose
32. Expansion tank
33. Glow plug relay
34. Thread forming screw
35. Flange lock nut
36. Bulkhead nut
37. Tube assembly
38. Flange nut (2 used)

Removal (Fig. 6)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. Open and remove hood from the machine (see Traction Unit Operator's Manual).

CAUTION

Do not open radiator cap or drain coolant if the radiator or engine is hot. Pressurized, hot coolant can escape and cause burns. Ethylene-glycol antifreeze is poisonous. Dispose of coolant properly or store it in a properly labeled container away from children and pets.

3. Place a suitable container under the radiator to collect the coolant. Open draincock valve and completely drain the radiator.

4. Remove glow plug relay from the radiator assembly. Position relay away from the radiator.

5. Disconnect following hoses from the radiator:

   A. Upper radiator hose to the water pump.

   B. Lower radiator hose to the engine block.

   C. Coolant hose to the expansion tank.

   D. Air hose to the air cleaner.

6. Remove expansion tank and bracket from the top fan shroud.

7. Remove upper and lower fan shrouds from radiator assembly.

8. Remove flange head screws securing the top and bottom of the radiator frame to the radiator. Remove four (4) carriage bolts and flange nuts securing the radiator to the radiator frame.

9. Carefully pull radiator from the radiator frame.

10. Plug radiator and hose openings to prevent contamination.

Installation (Fig. 6)

1. Remove any plugs placed in radiator and coolant hose openings during the removal procedure.

2. Carefully position radiator to the radiator frame.

3. Secure radiator to the radiator frame with four (4) carriage bolts and flange nuts. Secure top and bottom of radiator to frame with flange head screws.

4. Secure lower and upper fan shrouds to the radiator assembly with flange head screws.

5. Secure expansion tank bracket and tank to the top fan shroud with flange head screws and flange nuts.

6. Connect following hoses to the radiator:

   A. Upper radiator hose to the water pump.

   B. Lower radiator hose to the engine block.

   C. Coolant hose to the expansion tank.

   D. Air hose to the air cleaner.

7. Secure glow plug relay to the radiator assembly.

8. Make sure radiator draincock valve is closed. Fill radiator with coolant (see Traction Unit Operator's Manual).

9. Install hood to the machine (see Traction Unit Operator's Manual). Close and latch hood.

Engine

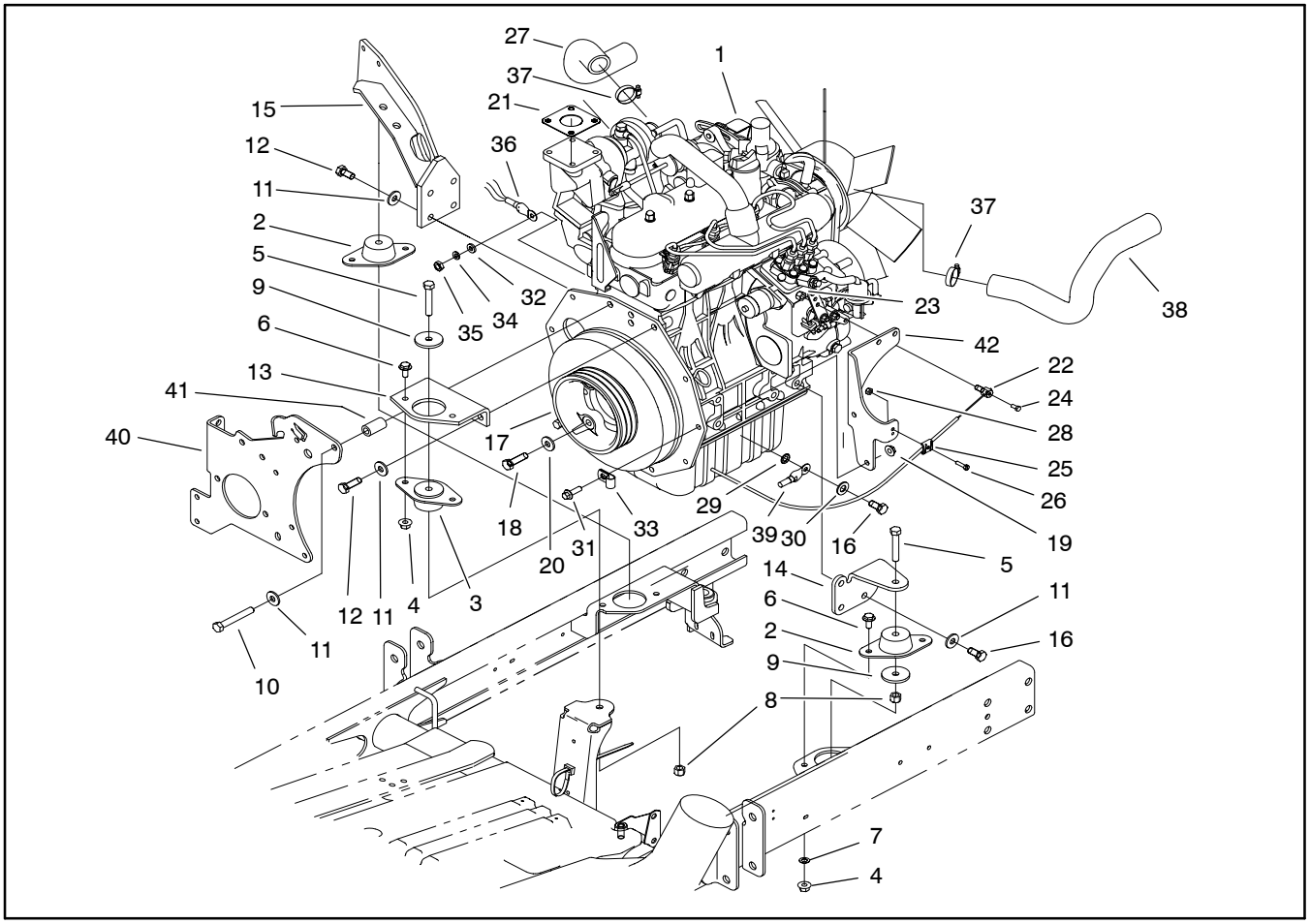

Figure 7

1. Kubota engine
2. Engine mount (2 used)
3. Engine mount
4. Flange nut (6 used)
5. Cap screw (3 used)
6. Flange head screw (6 used)
7. External lock washer
8. Lock nut (3 used)
9. Hardened washer (3 used)
10. Machine screw
11. Hardened washer (11 used)
12. Cap screw (5 used)
13. Engine mounting bracket (front)
14. Engine mounting bracket (LH)
15. Engine mounting bracket (RH)
16. Cap screw (4 used)
17. Pulley
18. Bolt (3 used)
19. Flange nut (2 used)
20. Flat washer (3 used)
21. Exhaust gasket
22. Throttle swivel
23. Lock nut
24. Slotted hex head screw
25. Throttle cable clamp
26. Cap screw
27. Radiator hose (lower)
28. Lock nut
29. Lock washer
30. Flat washer
31. Flange head screw (2 used)
32. Flat washer
33. R-clamp
34. Lock washer
35. Hex nut
36. Wire harness
37. Hose clamp
38. Radiator hose (upper)
39. Wire harness ground
40. Pump mount plate
41. Spacer
42. Throttle support bracket

Removal (Fig. 7)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. Open and remove hood from the machine (see Traction Unit Operator's Manual). Slide operator seat all the way forward.

3. Disconnect air hose from the air cleaner and radiator. Remove air cleaner from the engine (see Air Cleaner Assembly Removal in this section).

4. Disconnect both battery cables at the battery (see Battery Service in Chapter 5 – Electrical System).

5. Remove muffler from the exhaust manifold and muffler bracket (see Muffler Removal in this section).

6. Drain coolant from the radiator into a suitable container (see Radiator Removal in this section). Disconnect radiator hoses from the water pump and engine block.

7. Remove coolant expansion tank and bracket from the upper fan shroud. Remove upper fan shroud from the radiator (see Radiator Removal in this section).

8. Disconnect electrical wires from engine:

   A. Negative battery cable, wire harness ground and fuel stop solenoid (Fig. 8).

   B. Glow plug bus (Fig. 9).

   C. High temperature warning switch (Fig. 10).

   D. High temperature shutdown switch, alternator and oil pressure switch (Fig. 11).

9. Disconnect throttle cable from the throttle support bracket and swivel on the speed control lever (Fig. 8).

10. Disconnect fuel hoses from the fuel/water separator (Fig. 8). Position disconnected hose from fuel pump to prevent fuel leakage.

11. Remove traction control cable from the neutral arm assembly on the piston pump. Remove all hydraulic hoses from the piston and gear pumps (see Piston Pump Removal in the Service and Repairs section of Chapter 4– Hydraulic System).

12. Note location of cable ties securing the wire harness to engine. Remove cable ties.

13. Attach a suitable lift or hoist to lift tabs on front (Fig. 10) and rear (on air filter mount) of engine.

CAUTION

Make sure lift or hoist can support the total weight of the engine before removing the cap screws from the engine and engine brackets.

14. Remove flange nuts (item 4), flange head screws (item 6) and lock washer (item 7) securing three engine mounts to the engine mounting brackets.

CAUTION

One person should operate lift or hoist while a second person guides the engine out of the machine.

IMPORTANT: Make sure not to damage the engine, fuel hoses, hydraulic lines, electrical harness or other parts while removing the engine.

15. Slowly remove engine from the machine.

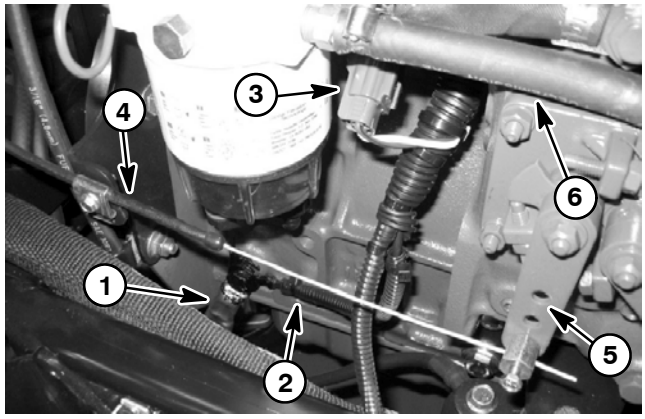

Figure 8

1. **Negative battery cable**
2. **Wire harness ground**
3. **Fuel stop solenoid**
4. **Throttle cable**
5. **Speed control lever**
6. **Fuel hose**

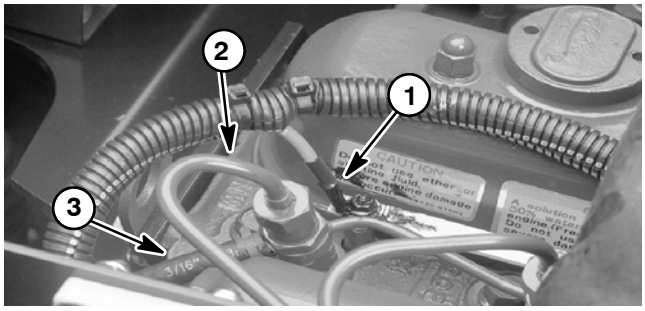

Figure 9

1. **Glow plug wire**
2. **Rear injector nozzle**
3. **Fuel hose**

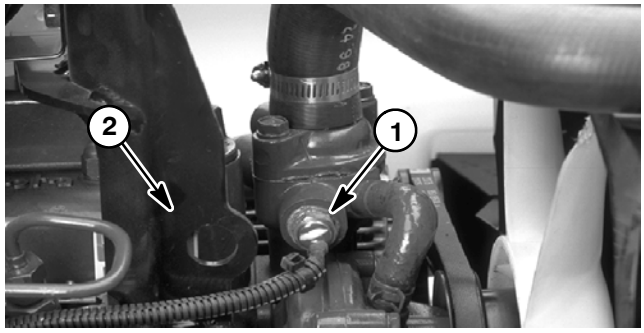

Figure 10

1. **Temp. warning switch**
2. **Front lift tab**

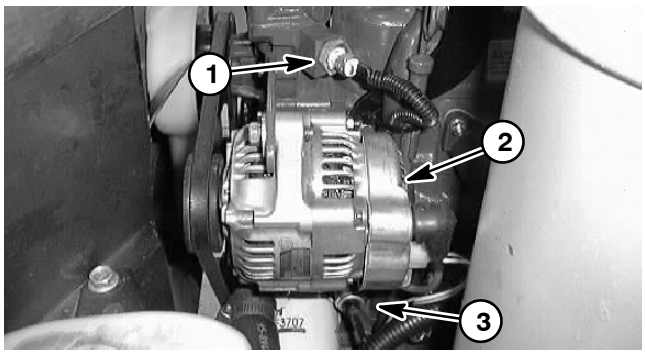

Figure 11

1. **Temp. shutdown switch**
2. **Alternator**
3. **Oil pressure switch**

16. Separate hydrostat and pump mount plate from the engine as follows:

A. Remove traction belt from the engine flywheel and hydrostat pulleys (see Traction Unit Operator's Manual).

B. Support hydraulic pump assembly to prevent it from falling during removal.

C. Remove five (5) cap screws, four (4) washers and five (5) spacers securing the pump mount plate to the engine (Fig. 12 and 13). Note location of spacers, washers and cap screws during removal.

D. Remove four (4) cap screws (item 12) and hardened washers (item 11) securing the right engine mounting bracket to the engine.

E. Remove hydrostat, pump mount plate and mounting brackets from engine.

17. As necessary, remove engine mounts (item 3), front engine mounting bracket (item 13), throttle support bracket (item 42) and left engine mounting bracket (item 14).

Installation (Fig. 7)

1. If removed, install engine mounts (item 3), front engine mounting bracket (item 13), throttle support bracket (item 42) and left engine mounting bracket (item 14). Also, make sure that all switches and sensors are installed on engine.

2. Install hydrostat, pump mount plate and mounting brackets to the engine as follows:

A. Position hydrostat, pump mount plate and mounting brackets to engine.

B. Secure right engine mounting bracket (with hydrostat attached) to the engine with four (4) hardened washers and cap screws.

NOTE: To prevent the torsion spring from binding, do not install flat washer on cap screw near the spring.

C. Using locations noted during engine removal, secure pump mount plate to the engine with five (5) spacers, four (4) washers and five (5) cap screws (Fig. 12 and 13).

D. Install traction belt to the engine flywheel and hydrostat pulleys (see Traction Unit Operator's Manual).

3. Connect hoist or lift to the front and rear engine lift tabs (Fig. 9 and 10).

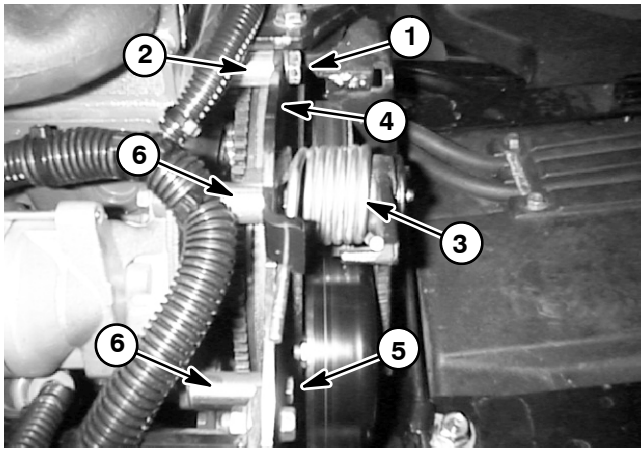

Figure 12

1. Cap screw (10 mm)
2. Short spacer
3. Torsion spring
4. Pump mount plate
5. Cap screw (8 mm)
6. Long spacer (4 used)

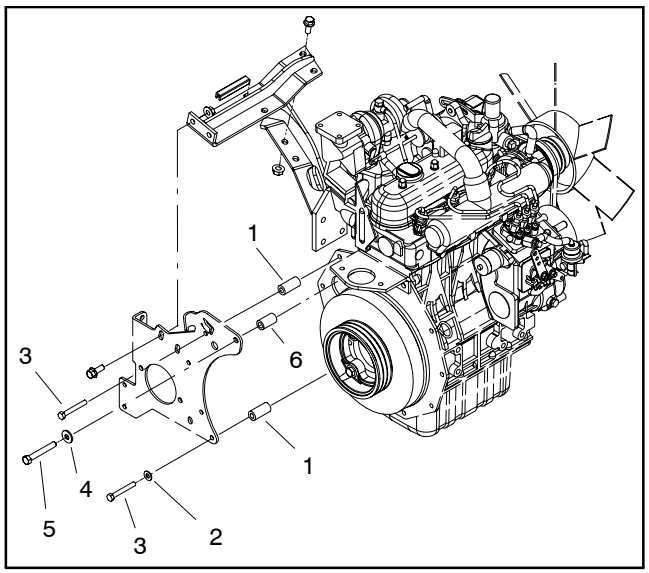

Figure 13

1. Long spacer (4 used)
2. Flat washer (3 used)
3. 8 mm cap screw (4 used)
4. Hardened washer
5. 10 mm cap screw
6. Short spacer

CAUTION

One person should operate lift or hoist while a second person guides the engine into the machine.

IMPORTANT: Make sure not to damage the engine, fuel or hydraulic lines, electrical harness or other parts while installing the engine.

4. Carefully lower engine into the machine.

5. Secure three (3) engine mounts to the engine mounting brackets with cap screws, washers and flange nuts.

6. Secure wire harness to the front lift tab and the engine with cable ties.

7. Install all hydraulic hoses to the piston and gear pumps. Install traction control cable to the neutral arm assembly on the piston pump (see Piston Pump Installation in Chapter 4– Hydraulic System).

8. Connect fuel hose to the fuel/water separator (Fig. 8) and front injector nozzle.

9. Install top fan shroud to the radiator. Install expansion tank and bracket to the top fan shroud (see Radiator Installation in this section).

10. Connect electrical wires to engine:

   A. Negative battery cable and wire harness ground (Fig. 8).

   B. Glow plug bus (Fig. 9) and fuel stop solenoid.

   C. High temperature warning switch (Fig. 10).

   D. High temperature shutdown switch, alternator and oil pressure switch (Fig. 11).

11. Secure wire harness to engine with cable ties at locations noted during engine removal.

12. Connect coolant hoses to the water pump and engine block. Close radiator drain cock valve. Fill radiator with coolant (see Traction Unit Operator's Manual).

13. Install muffler to the exhaust manifold and muffler bracket (see Muffler Installation in this section).

14. Connect throttle cable to the support bracket and swivel on the speed control lever (Fig. 8).

15. Connect both battery cables to the battery (see Battery Service in Chapter 5 – Electrical system).

16. Install air cleaner to the engine (see Air Cleaner Assembly Installation in this section). Connect air hose to air cleaner and radiator.

17. Adjust throttle cable (see Adjust Throttle Cable).

18. Bleed fuel system (see Traction Unit Operator's Manual).

19. Install hood to the machine (see Traction Unit Operator's Manual). Close and latch hood.

20. Check hydraulic oil level (see Traction Unit Operator's Manual). Adjust as needed.

21. Check traction drive for neutral (see Traction Unit Operator's Manual). Adjust as needed.

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Chapter 4

Hydraulic System

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ROSS TORQMOTOR ™ MG, MF, ME AND MJ SERIES SERVICE PROCEDURE
EATON MEDIUM DUTY PISTON PUMP REPAIR INFORMATION MODEL 70160 VARIABLE DISPLACEMENT PISTON PUMP
SAUER/DANFOSS STEERING UNIT TYPE OSPM SERVICE MANUAL

Specifications

Item	Description
Piston Pump (Hydrostat) (P3) Charge Pressure Traction Circuit Relief Pressure (Forward Only)	Variable displacement piston pump 100 to 150 PSI (6.9 to 10.3 bar) 3000 PSI (207 bar)
Gear Pump (P1 and P2) Section P1 Displacement Section P2 Displacement	Dual section, positive displacement, gear pump .946 in^3/rev. (15.5 cm^3/rev.) .31 in^3/rev. (5 cm^3/rev.)
Counterbalance Pressure (LC1)	250 PSI (17.2 bar)
Hydraulic Manifold Relief Pressure (R1)	3200 PSI (221 bar)
Cutting Unit Motor Cross-over Relief Pressure	Gear motor 1813 PSI (125 bar)
Wheel Motors	Orbital rotor motor
Steering Control Valve Implement (Steering and Lift) Relief Valve Pressure	Sauer Danfoss Steering Unit, Type OSPM 1000 PSI (69 bar)
Hydraulic Reservoir Capacity	6 Gal. U.S. (22.7 L)
Hydraulic Filter	10 Micron (nominal), spin-on cartridge type
Hydraulic Oil	See Traction Unit Operator's Manual

General Information

Hydraulic Hoses

Hydraulic hoses are subject to extreme conditions such as pressure differentials during operation and exposure to weather, sun, chemicals, very warm storage conditions or mishandling during operation or maintenance. These conditions can cause damage or premature deterioration. Some hoses are more susceptible to these conditions than others. Inspect the hoses frequently for signs of deterioration or damage.

When replacing a hydraulic hose, be sure that the hose is straight (not twisted) before tightening the fittings. This can be done by observing the imprint on the hose. Use two wrenches; hold the hose in position with one wrench and tighten the hose swivel nut onto the fitting with the second wrench.

WARNING

Before disconnecting or performing any work on hydraulic system, relieve all pressure in system (see Relieving Hydraulic System Pressure). Stop engine; lower or support cutting units and/or other attachment(s).

Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Use paper or cardboard, not hands, to search for leaks. Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and cause serious injury. If fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury. Gangrene may result from such an injury.

Hydraulic Fitting Installation

O-Ring Face Seal

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches or any foreign material.

2. Make sure the o-ring is installed and properly seated in the groove. It is recommended that the o-ring be replaced any time the connection is opened.

3. Lubricate the o-ring with a light coating of oil.

4. Put the tube and nut squarely into position on the face seal end of the fitting and tighten the nut until finger tight.

5. Mark the nut and fitting body. Hold the body with a wrench. Use a second wrench to tighten the nut to the correct Flats From Finger Tight (F.F.F.T.). The markings on the nut and fitting body will verify that the connection has been tightened.

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	0.75 ± 0.25
6 (3/8 in.)	0.75 ± 0.25
8 (1/2 in.)	0.75 ± 0.25
10 (5/8 in.)	1.00 ± 0.25
12 (3/4 in.)	0.75 ± 0.25
16 (1 in.)	0.75 ± 0.25

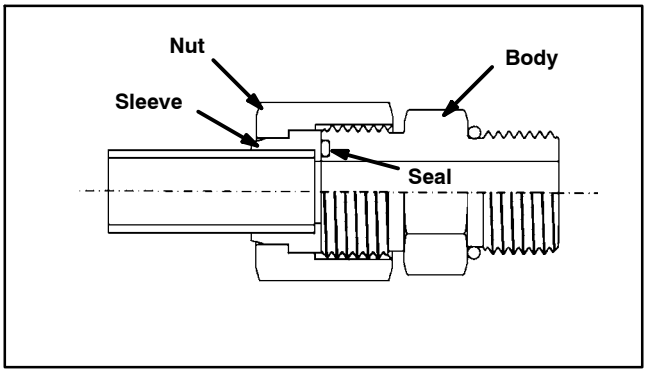


Figure 1

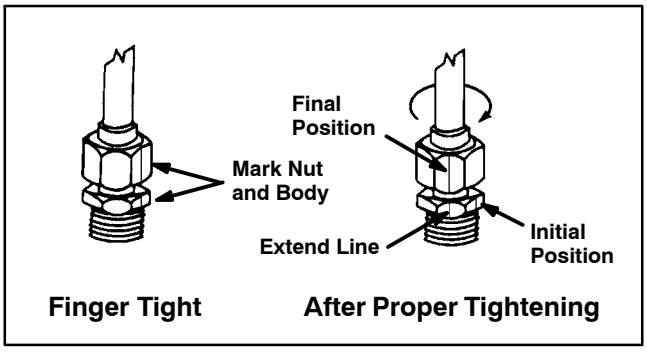


Figure 2

SAE Straight Thread O-Ring Port - Non-adjustable

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches or any foreign material.

2. Always replace the o-ring seal when this type of fitting shows signs of leakage.

3. Lubricate the o-ring with a light coating of oil.

4. Install the fitting into the port and tighten it down full length until finger tight.

5. Tighten the fitting to the correct flats from finger tight (F.F.F.T.).

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	1.00 ± 0.25
6 (3/8 in.)	1.50 ± 0.25
8 (1/2 in.)	1.50 ± 0.25
10 (5/8 in.)	1.50 ± 0.25
12 (3/4 in.)	1.50 ± 0.25
16 (1 in.)	1.50 ± 0.25

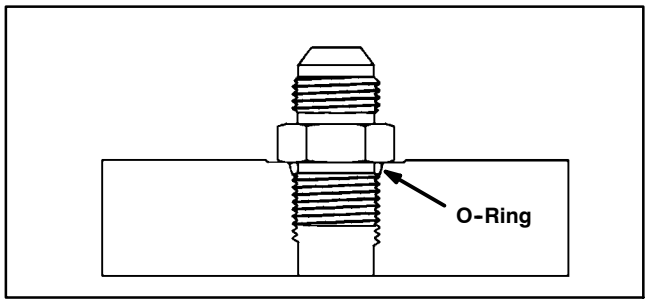


Figure 3

SAE Straight Thread O-Ring Port - Adjustable

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches or any foreign material.

2. Always replace the o-ring seal when this type of fitting shows signs of leakage.

3. Lubricate the o-ring with a light coating of oil.

4. Turn back the jam nut as far as possible. Make sure the back up washer is not loose and is pushed up as far as possible (Step 1).

5. Install the fitting into the port and tighten finger tight until the washer contacts the face of the port (Step 2).

6. To put the fitting in the desired position, unscrew it by the required amount, but no more than one full turn (Step 3).

7. Hold the fitting in the desired position with a wrench and turn the jam nut with a second wrench to the correct Flats From Finger Tight (F.F.F.T.) (Step 4).

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	1.00 ± 0.25
6 (3/8 in.)	1.50 ± 0.25
8 (1/2 in.)	1.50 ± 0.25
10 (5/8 in.)	1.50 ± 0.25
12 (3/4 in.)	1.50 ± 0.25
16 (1 in.)	1.50 ± 0.25

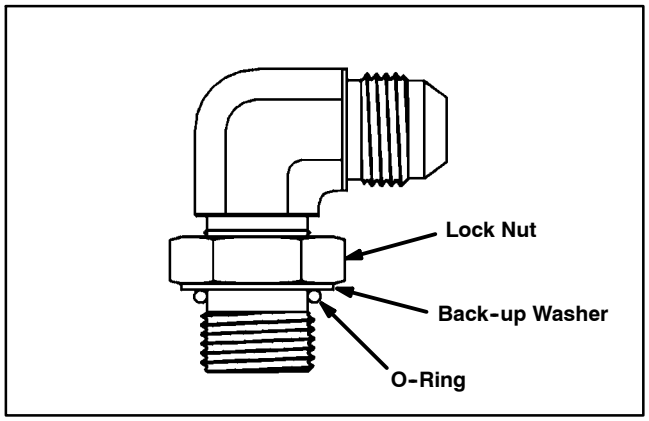


Figure 4

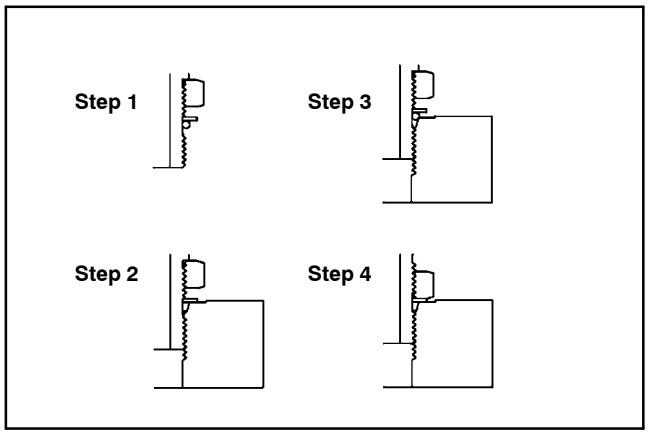


Figure 5

Towing Traction Unit

In case of emergency, the Groundsmaster 3505−D can be towed (or pushed) for a very short distance. However, Toro does not recommend this as a standard procedure.

1. Locate by−pass valve on hydrostat pump (Fig. 6) and rotate it 90º to open the by−pass valve. This open position should be horizontal (Fig. 7).

IMPORTANT: Do not tow (or push) the machine faster than 2 to 3 mph because the drive system may be damaged. If machine must be moved a considerable distance (more than a few feet), transport it on a truck or trailer.

2. Slowly tow (or push) machine.

3. Before starting engine, close by−pass valve by rotating it 90º. This closed position should be vertical (Fig. 7). Do not start engine when by−pass valve is open.

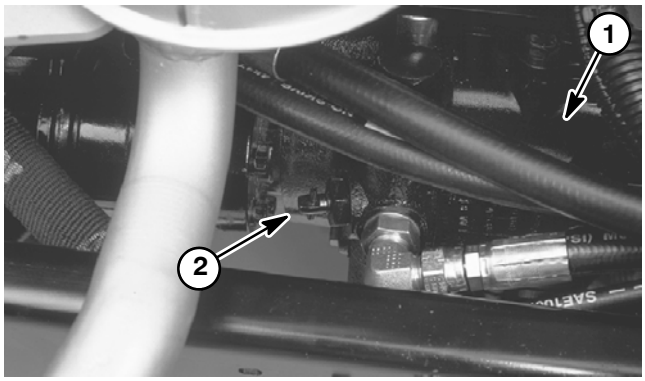


Figure 6

1. **Hydrostat pump**
2. **By−pass valve**

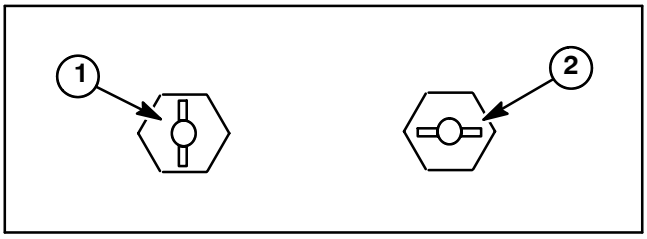


Figure 7

1. **Valve closed position**
2. **Valve open position**

Relieving Hydraulic System Pressure

Before disconnecting or performing any work on the Groundsmaster 3505−D hydraulic system, all pressure in the hydraulic system must be relieved. Park machine on a level surface with the cutting units lowered and off. Turn key switch to OFF and allow engine to stop.

To relieve hydraulic pressure in traction circuit, move traction lever to both forward and reverse directions. To relieve hydraulic pressure in steering and lift circuits, rotate steering wheel in both directions.

To relieve cutting unit system pressure, turn key switch to ON (engine not running). Move PTO switch to engage which will energize the solenoid valve on hydraulic manifold to relieve circuit pressure. Move PTO switch to disengage, return key switch to OFF and remove key from the ignition switch.

NOTE: Moving steering wheel with engine off may unseat implement relief valve. If steering or lift circuits appear weak or inoperative after machine is returned to service, repeat relieving hydraulic system pressure procedure.

Traction Circuit (Closed Loop) Component Failure

The Groundsmaster 3505–D traction circuit is a closed loop system that includes the hydrostat and two (2) wheel motors. If a component in the traction circuit should fail, debris and contamination from the failed component will circulate throughout the traction circuit. This contamination can damage other components in the circuit so it must be removed to prevent additional component failure.

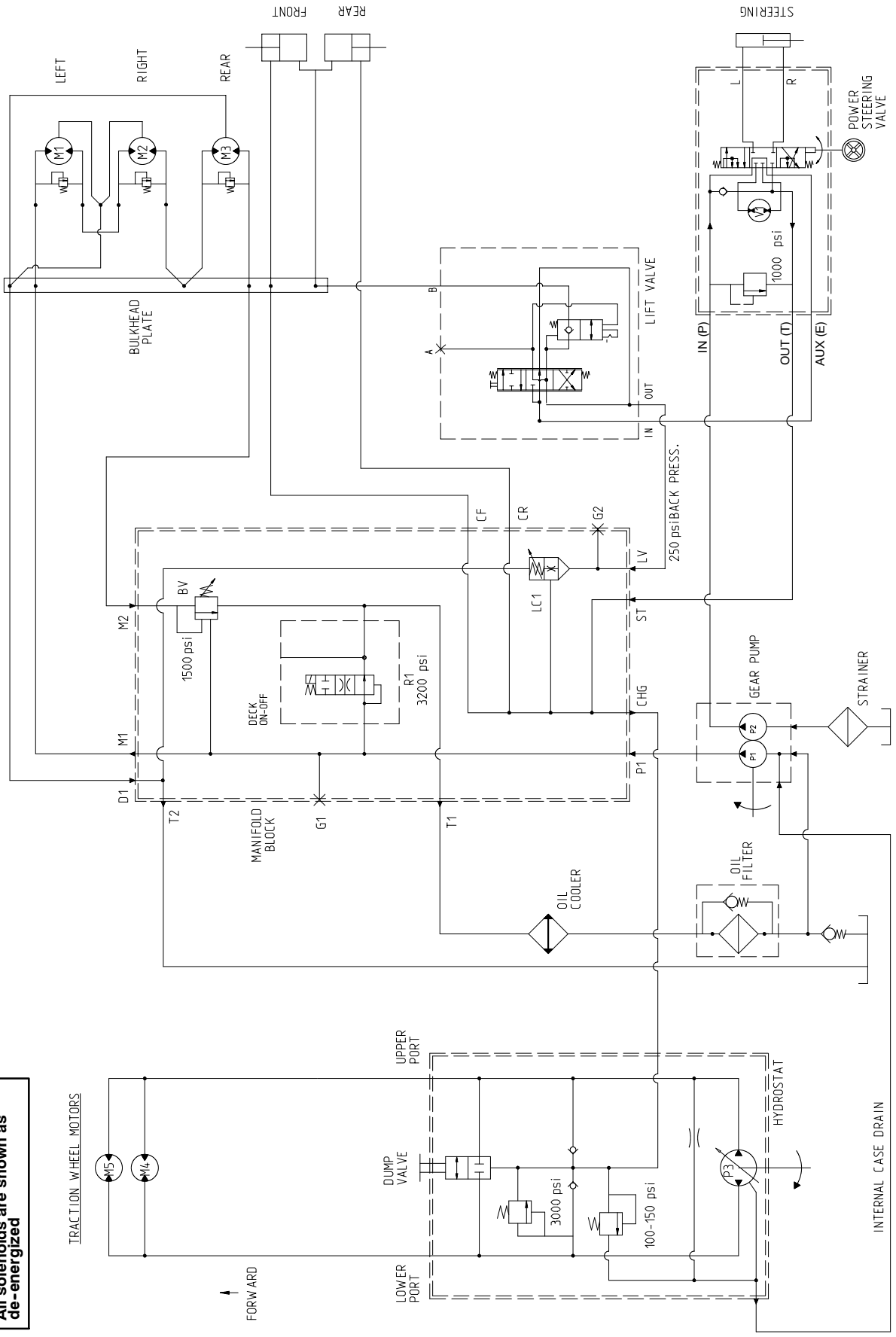
If a component failure occurs in the traction circuit, it is critical that the entire traction circuit be disassembled, drained and thoroughly cleaned to ensure that all contamination is removed from the circuit. If any debris remains in the traction circuit and the machine is operated, the debris can cause additional component failure.

An additional step for removing all traction circuit contamination would be to temporarily install a high pressure hydraulic oil filter (see Special Tools) into the circuit. The filter could be used when connecting hydraulic test gauges in order to test traction circuit components or after replacing a failed traction circuit component (e.g. hydrostat or wheel motor). The filter will ensure that contaminates are removed from the closed loop and thus, do not cause additional component damage.

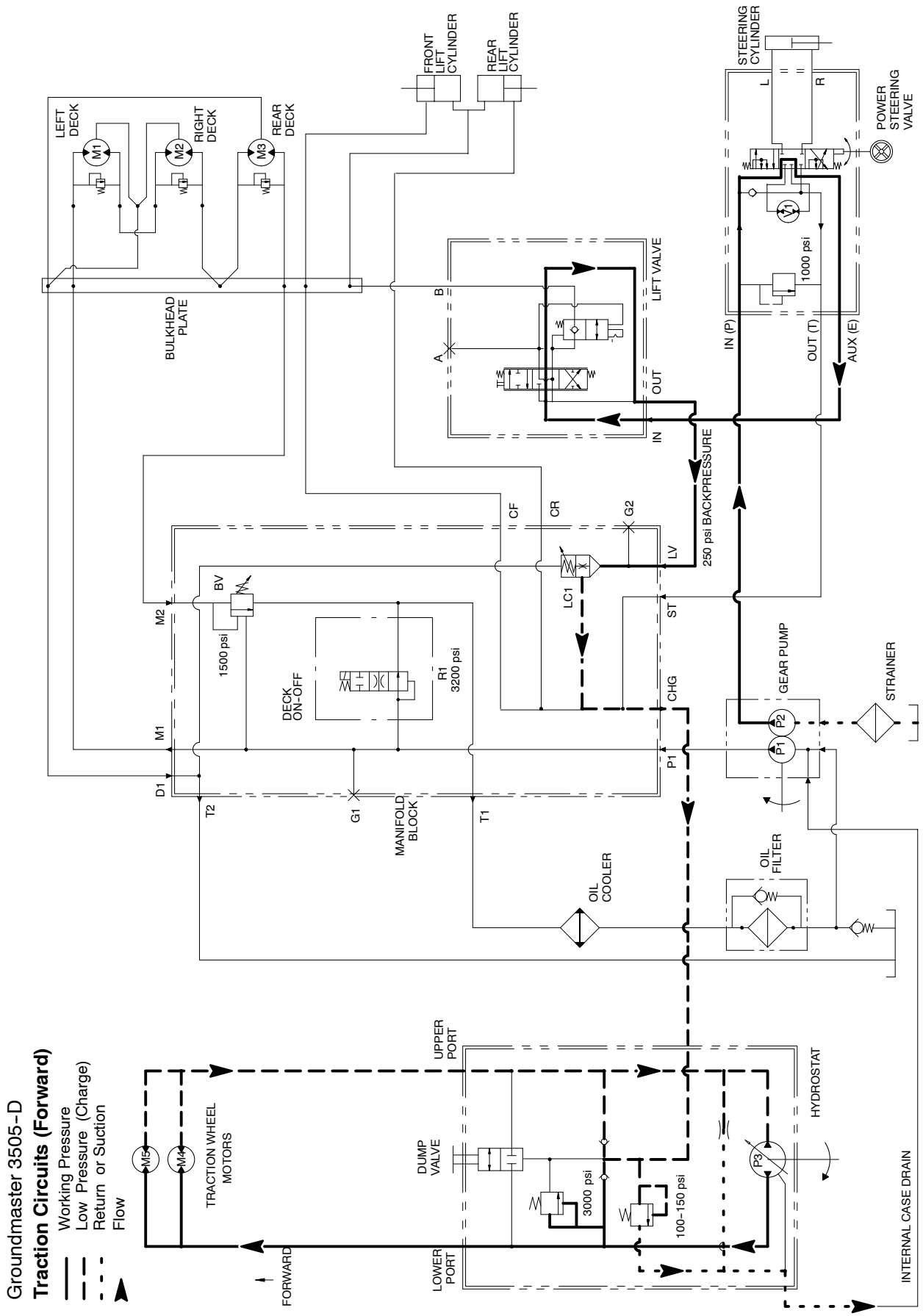
Once the filter has been placed in the traction circuit, place the machine on jack stands and operate the traction circuit to allow oil flow through the circuit. With the machine raised off the ground, the traction circuit will have maximum oil flow at minimum pressure to minimize damage from any remaining contamination. The filter will remove contamination from the closed loop traction circuit during operation. Remove the filter from the machine after contamination has been removed from the traction circuit.

IMPORTANT: When operating the traction system with the high pressure filter installed, make sure that flow is always directed through the filter (e.g. do not press the traction pedal in the reverse direction if the filter is placed for forward direction flow). If flow is reversed, debris from the filter will re–enter the traction circuit.

Hydraulic Schematic



Hydraulic Flow Diagrams



Traction Circuits

Forward

The traction circuit of the hydraulic system consists of a hydrostat connected in a closed loop circuit to two orbital rotor wheel motors.

The engine drives traction pump (P3) indirectly through pulleys and a V–belt. The traction pump is a variable displacement piston pump. The traction pedal connects through a cable to the trunnion shaft and swash plate of the pump. With the engine running and the traction pedal in the neutral position, traction pump (P3) supplies no flow to the wheel motors. When the traction pedal is pressed to the forward position, the cable from the pedal positions the swash plate in the traction pump so oil flows out of the lower port. Oil flow out of the lower port goes to the wheel motors and turns them in the forward direction. Oil flowing out of the wheel motors returns to the upper port of the hydrostat and is continuously pumped out of the lower port.

As the load increases, forward traction circuit pressure can increase to the relief valve setting of 3000 PSI (207 bar). If pressure exceeds the relief setting, oil flows through the relief valve in the hydrostat to the low pressure side of the closed loop traction circuit.

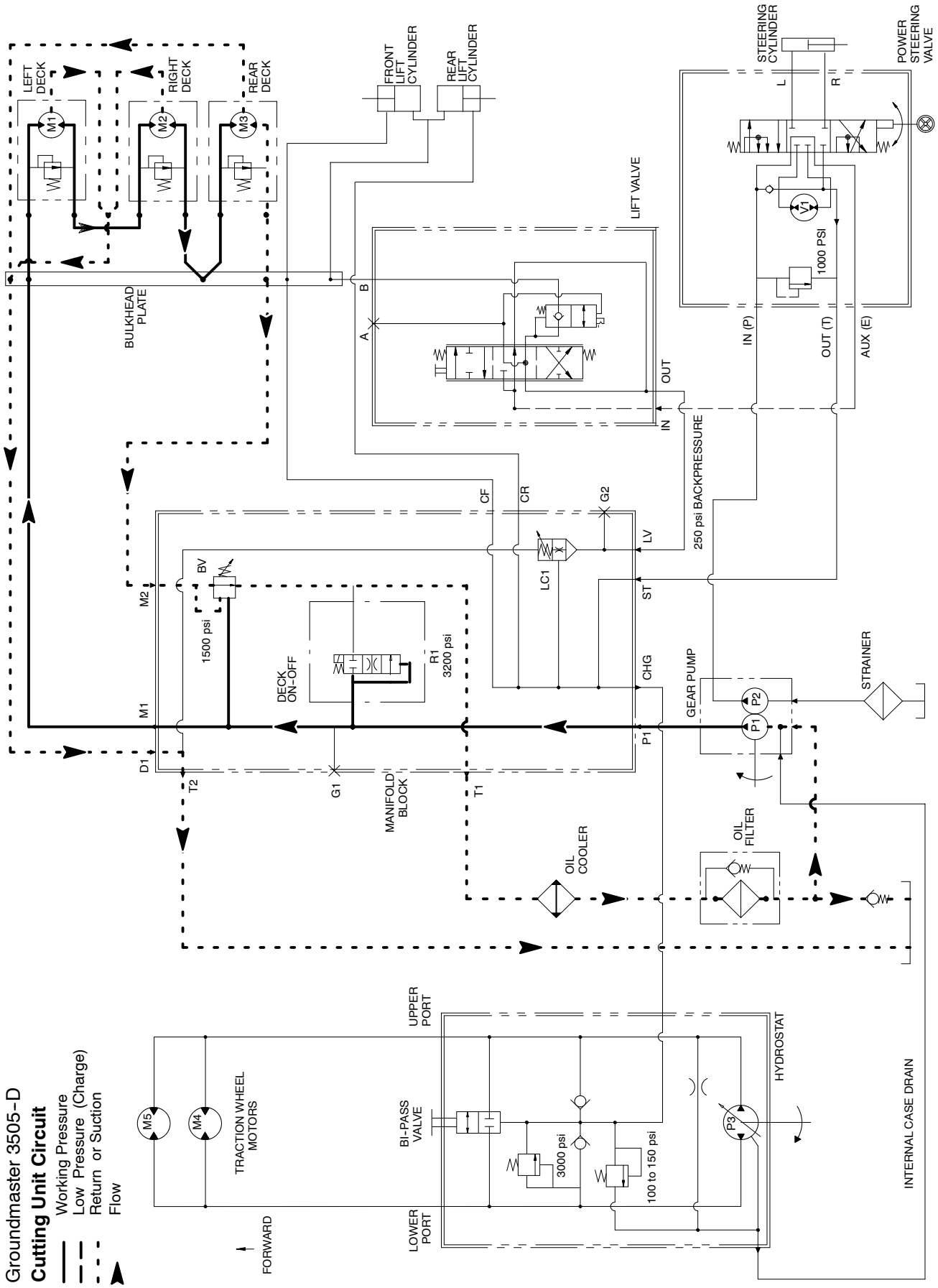
The traction pump uses a small amount of hydraulic fluid for internal lubrication. Fluid is designed to leak across pump parts into the case drain. This leakage results in the loss of hydraulic fluid from the closed loop traction circuit that must be replenished.

A two section gear pump is directly coupled to the the hydrostat. Gear pump section (P2) supplies hydraulic flow for maintaining 100 to 150 PSI (6.9 to 10.3 bar) to the low pressure side of the traction circuit (charge), raising and lowering the cutting units and operating the steering system. The pump replenishes the closed loop traction circuit with fluid from the hydraulic tank. The charge relief valve in the hydrostat maintains sufficient pressure so that pump flow is guided to the low pressure side of the traction circuit through one of two check valves. Pump flow in excess of replenishment requirements is relieved through the charge relief valve back to gear pump (P1) inlet.

Reverse

The traction circuit operates essentially the same in reverse as it does in forward. However, there are a few differences in operation.

When the reverse traction pedal is depressed, the cable from the pedal positions the swash plate in the traction pump (P3) so oil flows out of the upper port. Oil flow out of the upper port goes to the wheel motors and turns them in the reverse direction. Oil flowing out of the wheel motors returns to the lower port of the hydrostat and is continuously pumped out of the upper port.


Groundmaster 3505-D
Cutting Unit Circuit
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
LEFT DECK
RIGHT DECK
REAR DECK
M1
M2
M3
FRONT LIFT CYLINDER
REAR LIFT CYLINDER
LIFT VALVE
STEERING CYLINDER
POWER STEERING VALVE
L
R
V1
1000 PSI
IN (P)
OUT (T)
AUX (E)
BULKHEAD PLATE
A
B
OUT
IN
250 psi BACKPRESSURE
CF
CR
G2
LV
LC1
ST
BV
1500 psi
M2
M1
D1
T2
G1
MANIFOLD BLOCK
T1
DECK ON-OFF
R1
3200 psi
CHG
GEAR PUMP
P2
P1
STRAINER
OIL COOLER
OIL FILTER
UPPER PORT
LOWER PORT
BI-PASS VALVE
3000 psi
100 to 150 psi
HYDROSTAT
P3
M5
M4
TRACTION WHEEL MOTORS
FORWARD
INTERNAL CASE DRAIN

Cutting Unit Circuit

Mow

A two section gear pump is directly coupled to the the hydrostat which is driven by the engine. Gear pump section (P1) supplies oil flow to the cutting unit circuit through the manifold block and to the cutting unit motors.

Solenoid valve (R1) in the manifold block is de–energized when either the PTO switch is in DISENGAGE or the transport/mow slide is in TRANSPORT. When de–energized, solenoid valve (R1) by–passes flow from the cutting unit motors. Flow returns to gear pump (P1) inlet.

Solenoid valve (R1) is energized when the PTO switch is in ENGAGE and the transport/mow slide is in MOW. When energized, solenoid valve (R1) allows gear pump (P1) flow out manifold block port M1 to the cutting unit motors. When solenoid valve (R1) is energized, brake relief cartridge (BV) is shifted (opens) to allow oil return from the cutting unit motors.

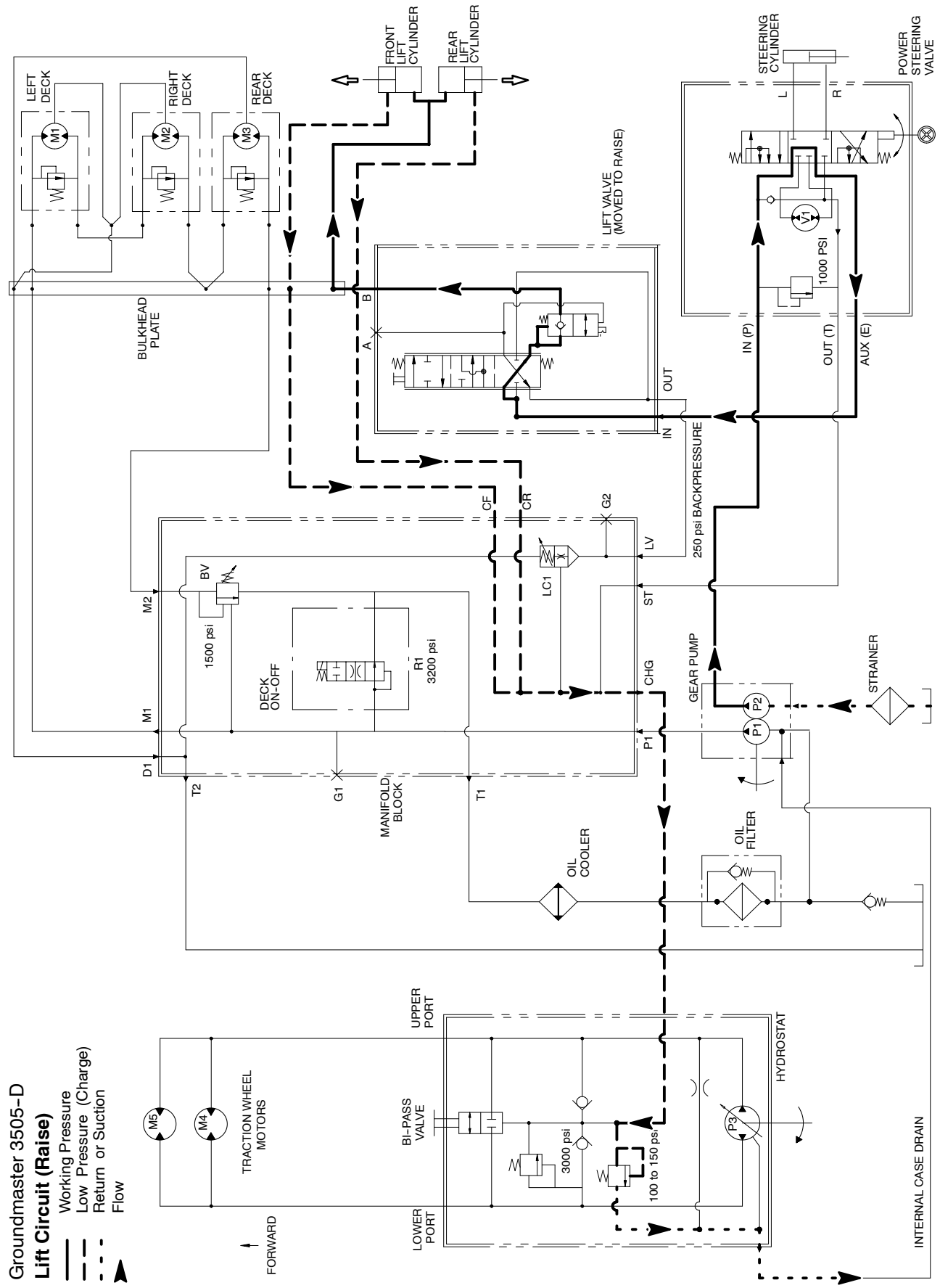
Oil flows through the left, right and then rear cutting unit motors as it turns the motors. The oil then returns through manifold block port (M2), the oil cooler, the oil filter and to gear pump (P1) inlet.

If cutting unit circuit pressure exceeds relief pressure of 3200 PSI (221 bar), solenoid valve (R1) shifts to allow circuit pressure relief.

Cutting Unit Blade Braking

When the solenoid valve (R1) is de–energized as the PTO switch is DISENGAGED, brake relief cartridge (BV) shifts to its closed position, blocking return flow from the deck motors and slowing the cutting blades

The inertia of the rotating cutting blades, however, effectively turns the deck motors into pumps causing an increase in pressure as the flow from the motors comes up against the closed brake relief cartridge (BV). When this pressure builds to approximately 1500 PSI (103 bar), brake relief cartridge (BV) opens which allows hydraulic flow to return to tank and reduces return pressure. When return pressure drops below 1500 PSI (103 bar), brake relief cartridge (BV) reseats to further slow the cutting blades. This action repeats several times in a very short time frame as the blades finally come to a stop. Once the blades have stopped, brake relief cartridge (BV) remains seated to keep the deck motors from rotating.


Groundmaster 3505-D
Lift Circuit (Raise)
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
FRONT LIFT CYLINDER
REAR LIFT CYLINDER
LEFT DECK
RIGHT DECK
REAR DECK
M1
M2
M3
BULKHEAD PLATE
LIFT VALVE (MOVED TO RAISE)
STEERING CYLINDER
POWER STEERING VALVE
L
R
V1
1000 PSI
IN (P)
OUT (T)
AUX (E)
A
B
OUT
IN
250 psi BACKPRESSURE
CF
CR
G2
LV
LC1
ST
CHG
BV
1500 psi
DECK ON-OFF
R1
3200 psi
M2
M1
D1
T2
G1
MANIFOLD BLOCK
T1
P1
GEAR PUMP
P2
STRAINER
OIL COOLER
OIL FILTER
UPPER PORT
BI-PASS VALVE
3000 psi
100 to 150 psi
HYDROSTAT
P3
M5
M4
TRACTION WHEEL MOTORS
LOWER PORT
FORWARD
INTERNAL CASE DRAIN

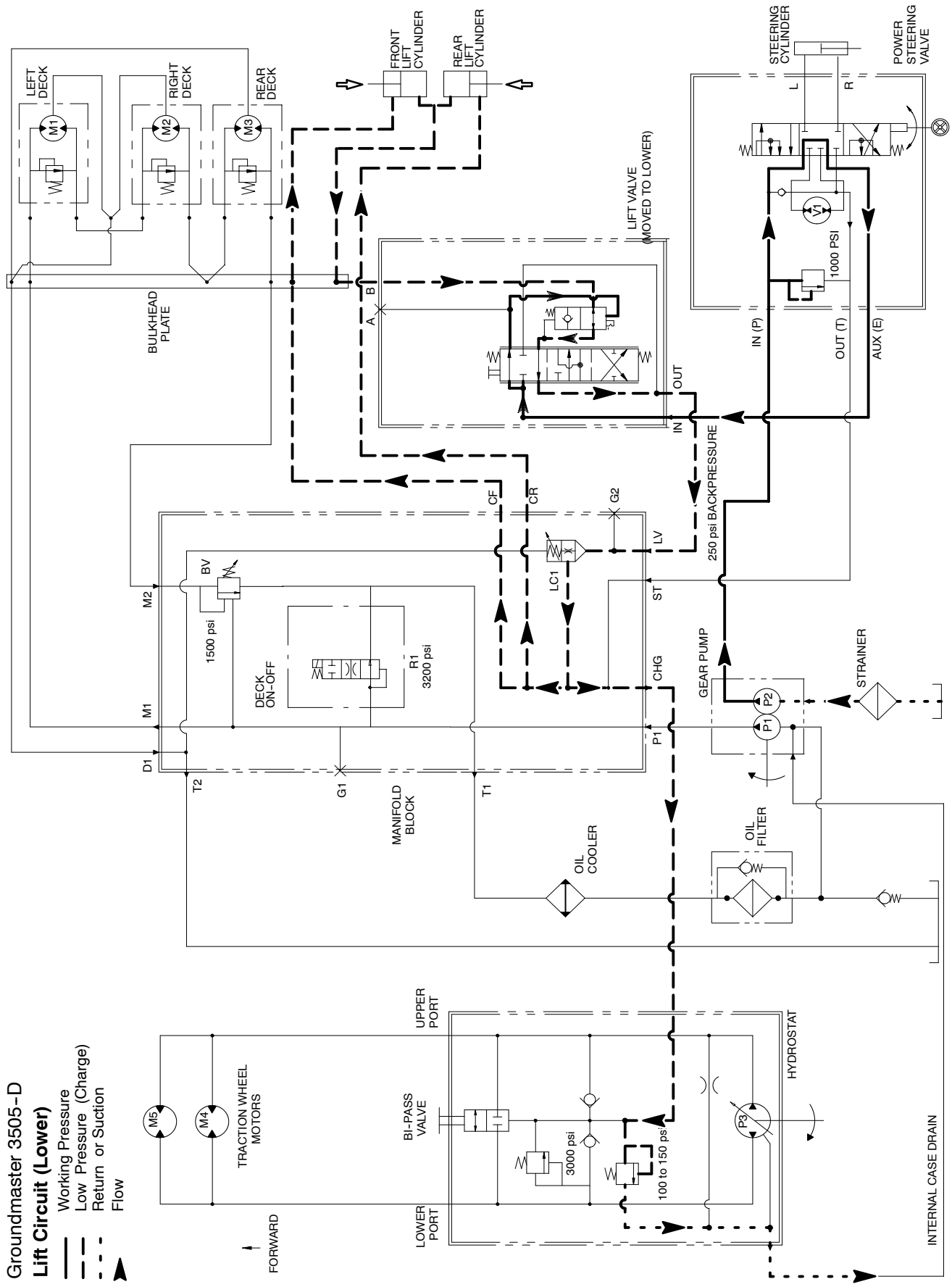
Lift Circuit (Raise)

A two section gear pump is directly coupled to the the hydrostat which is driven by the engine. Gear pump section (P2) supplies hydraulic flow for raising and lowering the cutting units, operating the steering system and maintaining 100 to 150 PSI (6.9 to 10.3 bar) to the low pressure side of the traction circuit (charge). The pump section (P2) takes its suction from the hydraulic reservoir.

During conditions of not lifting or lowering cutting units, flow from the gear pump (P2) is by–passed through the steering control valve, lift control valve and hydraulic manifold directly to the hydrostat and the charge relief valve. Flow then returns to the hydraulic tank.

When the cutting units are to be raised, the lift control valve is positioned by moving the lift control lever to RAISE. Flow is directed to the cap ends of the lift cylinders. Hydraulic pressure against the cylinder pistons moves their shafts causing the cutting units to raise. At the same time, the pistons push the hydraulic fluid out of the lift cylinders and back through the hydraulic manifold block to the hydrostat (charge).

When the lift control lever is released from RAISE, spring action returns the valve to its original position and by–passes flow back to the hydrostat (charge), stopping lift cylinder movement. The cylinder position is locked in place by the load holding checks in the lift control valve.


Groundmaster 3505-D
Lift Circuit (Lower)
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
LEFT DECK
RIGHT DECK
REAR DECK
M1
M2
M3
FRONT LIFT CYLINDER
REAR LIFT CYLINDER
STEERING CYLINDER
POWER STEERING VALVE
L
R
V1
1000 PSI
LIFT VALVE (MOVED TO LOWER)
BULKHEAD PLATE
A
B
IN (P)
OUT (T)
AUX (E)
OUT
IN
250 psi BACKPRESSURE
CF
CR
G2
LV
LC1
BV
1500 psi
DECK ON-OFF
R1
3200 psi
M2
M1
D1
T2
G1
T1
MANIFOLD BLOCK
ST
CHG
P1
GEAR PUMP
P2
P1
STRAINER
OIL COOLER
OIL FILTER
M5
M4
TRACTION WHEEL MOTORS
FORWARD
UPPER PORT
LOWER PORT
BI-PASS VALVE
3000 psi
100 to 150 psi
P3
HYDROSTAT
INTERNAL CASE DRAIN

Lift Circuit (Lower)

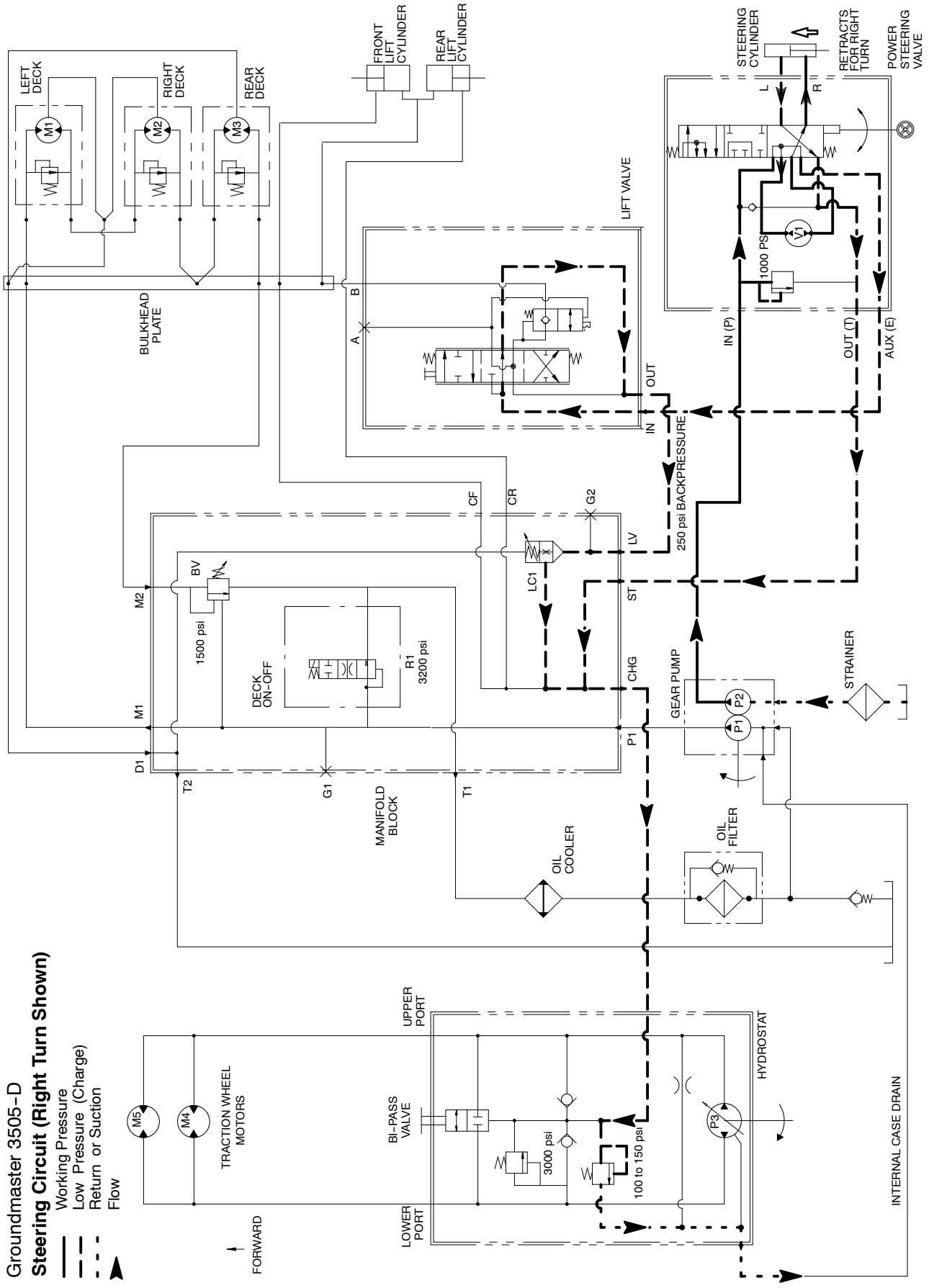
Circuit operation for lowering the cutting units is similar to raising them. However, pressure is relieved from the lift cylinders and this action allows the cutting units to lower.

During conditions of not lifting or lowering cutting units, flow from gear pump (P2) is by–passed through the steering control valve, lift control valve and hydraulic manifold directly to the hydrostat (charge). Flow then returns to gear pump (P1) inlet.

When the cutting units are to be lowered, the lift control valve is positioned by moving the lift control lever to LOWER. Pressure from gear pump (P2) is used to shift the pilot valve in the control valve. This shifted pilot valve allows hydraulic pressure to relieve from the cap end of the lift cylinders. Flow from the cap end of the lift cylinders causes the cutting units to lower. At the same time, the fluid relieved from the cap end of the lift cylinders goes into the rod end of the cylinders and back through the hydraulic manifold block to the hydrostat (charge).

When the lift control lever is released, spring action returns the valve to its original position and by–passes flow back to the hydrostat (charge). The pilot valve remains shifted to allow the lift cylinders to float until the lift control valve is moved to the raise position.

The logic cartridge valve (LC1) in the manifold block maintains 250 PSI (17.2 bar) back pressure on the lift cylinders. This counterbalance pressure transfers cutting unit weight to the machine to improve traction.


Groundmaster 3505-D
Steering Circuit (Right Turn Shown)
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
LEFT DECK
RIGHT DECK
REAR DECK
M1
M2
M3
FRONT LIFT CYLINDER
REAR LIFT CYLINDER
STEERING CYLINDER
RETRACTS FOR RIGHT TURN
POWER STEERING VALVE
L
R
LIFT VALVE
BULKHEAD PLATE
A
B
OUT
IN
1000 PSI
V1
IN (P)
OUT (T)
AUX (E)
250 psi BACKPRESSURE
CF
CR
G2
LV
LC1
ST
BV
1500 psi
DECK ON-OFF
R1
3200 psi
CHG
GEAR PUMP
P1
P2
STRAINER
M2
M1
D1
T2
G1
T1
MANIFOLD BLOCK
OIL COOLER
OIL FILTER
UPPER PORT
LOWER PORT
BI-PASS VALVE
3000 psi
100 to 150 psi
HYDROSTAT
P3
M5
M4
TRACTION WHEEL MOTORS
FORWARD
INTERNAL CASE DRAIN

Steering Circuit

A two section gear pump is directly coupled to the the hydrostat which is driven by the engine. Gear pump section (P2) supplies hydraulic flow for operating the steering system, raising and lowering the cutting units and maintaining 100 to 150 PSI (6.9 to 10.3 bar) to the low pressure side of the traction circuit (charge). The pump section (P2) takes its suction from the hydraulic reservoir.

With the engine running and the steering control valve in the centered position, flow enters the steering control valve at the IN (P) port and goes through the control valve, by–passing the rotary meter (V1) and steering cylinder. Flow leaves the control valve through the AUX (E) port to be available for the lift circuit and then to the hydrostat (charge).

Right Turn

When a right turn is made with the engine running, the turning of the steering wheel positions the control valve so that flow goes through the bottom of the valve. Flow entering the steering control valve at the IN (P) port goes through the valve and is routed to two places. First, most of the flow through the valve is by–passed out the AUX (E) port back through the lift control valve to the hydrostat. Second, the remainder of the flow is drawn through the rotary meter (V1) and out port (R) to the steering cylinder. Flow to the steering cylinder retracts the piston for a right turn. The rotary meter (V1) ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the steering cylinder flows back through the steering control valve then through the OUT (T) port and to the hydrostat (charge).

The steering control valve returns to the neutral position when turning is complete.

Left Turn

When a left turn is made with the engine running, the turning of the steering wheel positions the steering control valve so that flow goes through the top of the valve. Flow entering the steering control valve at the IN (P) port goes through the spool and is routed to two places. As in a right turn, most of the flow through the valve is by–passed out the AUX (E) port back through the lift control and to the hydrostat (charge). Also like a right turn, the remainder of the flow is drawn through rotary meter (V1) but goes out port (L) to the steering cylinder. Flow extends the steering cylinder piston for a left turn. The rotary meter (V1) ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the steering cylinder flows back through the steering control valve then through the OUT (T) port and to the hydrostat (charge).

The steering control valve returns to the neutral position when turning is complete.

Special Tools

Order these special tools from your Toro Distributor.

Hydraulic Pressure Test Kit

Toro Part Number: **TOR47009**

Use to take various pressure readings for diagnostic tests. Quick disconnect fittings provided attach directly to mating fittings on machine test ports without tools. A high pressure hose is provided for remote readings. Contains one each: 1000 PSI (70 Bar), 5000 PSI (350 Bar) and 10000 PSI (700 Bar) gauges. Use gauges as recommended in Testing section of this chapter.

Figure 8

Hydraulic Tester (Pressure and Flow)

Toro Part Number: **TOR214678**

This tester requires O−ring Face Seal (ORFS) adapter fittings for use on this machine (see Hydraulic Test Fitting Kit − TOR4079 in this section).

1. INLET HOSE: Hose connected from the system circuit to the inlet side of the hydraulic tester.

2. LOAD VALVE: A simulated working load is created in the circuit by turning the valve to restrict flow.

3. LOW PRESSURE GAUGE: Low range gauge to provide accurate reading at low pressure: 0 to 1000 PSI.

   A protector valve cuts out when pressure is about to exceed the normal range for the gauge. The cutout pressure is adjustable.

4. HIGH PRESSURE GAUGE: High range gauge which accommodates pressures beyond the capacity of the low pressure gauge: 0 to 5,000 PSI.

5. FLOW METER: This meter measures actual oil flow in the operating circuit with a gauge rated at 15 GPM.

6. OUTLET HOSE: A hose from the outlet side of the hydraulic tester connects to the hydraulic system circuit.

Figure 9

Hydraulic Test Fitting Kit

Toro Part Number: **TOR4079**

This kit includes a variety of O−ring Face Seal fittings to enable the connection of test gauges into the system.

The kit includes: tee's, unions, reducers, plugs, caps and male test fittings.

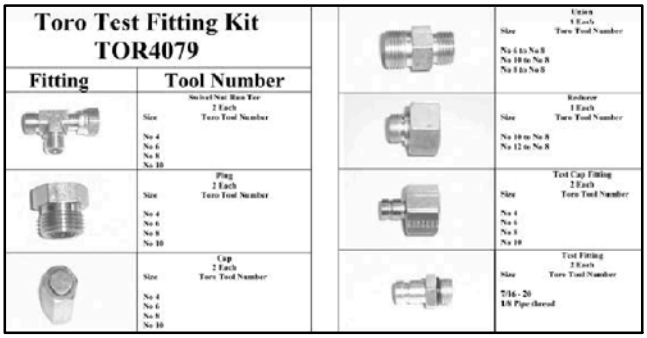


Figure 10

Measuring Container

Toro Part Number: **TOR4077**

Use this graduated container for doing hydraulic motor efficiency testing (motors with case drain lines only). Measure efficiency of a hydraulic motor by restricting the outlet flow from the motor and measuring leakage from the case drain line while the motor is pressurized by the hydraulic system.

The table in Figure 12 provides gallons per minute (GPM) conversion for measured milliliter or ounce leakage.

Figure 11

GPM	Milliliters in 15 sec.	Ounces in 15 sec.
.1	95	3.2
.2	189	6.4
.3	284	9.6
.4	378	12.8
.5	473	16.0
.6	568	19.2
.7	662	22.4
.8	756	25.6
.9	852	28.8
1.0	946	32.0

Figure 12

O-Ring Kit

Toro Part Number: **16-3799**

The kit includes o-rings in a variety of sizes for face seal and port seal hydraulic connections. It is recommended that o-rings be replaced whenever a hydraulic connection is loosened.

Figure 13

Wheel Hub Puller

Part Number: **TOR4097**

The wheel hub puller allows safe removal of the wheel hub from the shaft of wheel motors.

Figure 14

High Pressure Hydraulic Oil Filter

If a component failure occurs in the closed loop traction circuit, contamination from the failed part will remain in the circuit until removed. When connecting hydraulic test gauges in order to test traction circuit components or after replacing a failed traction circuit component (e.g. hydrostat or wheel motor), a high pressure hydraulic filter can be installed in the traction circuit. The filter will ensure that contaminates are removed from the closed loop and thus, do not cause additional component damage.

A high pressure hydraulic oil filter can be obtained locally.

Figure 15

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Troubleshooting

The chart that follows contains information to assist in troubleshooting. There may possibly be more than one cause for a machine malfunction.

Refer to the Testing section of this Chapter for precautions and specific hydraulic test procedures.

Problem	Possible Cause
Hydraulic oil leaks from system.	Fitting(s), hose(s) or tube(s) are loose or damaged. O–ring(s) or seal(s) are missing or damaged.
Hydraulic fluid foams.	Oil level in reservoir is low. Hydraulic system has wrong type of oil. One of the pump suction lines has an air leak. Incompatible hydraulic oils mixed in system. Water in hydraulic system.
Hydraulic system operates hot.	Transmission pressure is high due to load or brakes applied. Oil level in reservoir is low or inlet filter is loose or clogged. Oil is contaminated or oil viscosity is too light. Oil cooler is damaged or plugged. By–pass relief is stuck open or air flow is obstructed. Hydrostat by–pass valve is open or defective. Charge pressure is low. Wheel motor(s) or cutting unit motor(s) are worn or damaged. Traction pump is worn or damaged.
Neutral is difficult to find or unit operates in one direction only.	External control linkage is misadjusted, disconnected, binding or damaged. Traction pump is worn or damaged.
Traction response is sluggish.	Hydrostat by–pass valve is open or defective. Brake is not released. Charge pressure is low. Hydraulic oil is very cold. Traction pump or wheel motor(s) are worn or damaged.
No traction exists in either direction.	Brake is not released. Oil level in reservoir is low. Hydrostat by–pass valve is open. Traction pump drive belt is loose or broken. Charge pressure is low. Traction pump or wheel motor(s) are worn or damaged.

Problem	Possible Cause
Wheel motor will not turn.	Brakes are binding. Key on wheel motor shaft is sheared or missing. Internal parts in wheel motor are damaged.
Wheel motor will not hold load in neutral.	Make up fluid from charge pump is not available. Hydrostat ball check valves are damaged.
Cutting unit gear pump (P1) is noisy (cavitation).	Reservoir oil level is low. Suction line is restricted. Suction line has an air leak.
Cutting blades will not turn.	Solenoid valve (R1) is stuck open. An electrical problem exists (See Chapter 5 – Electrical System). Gear pump (P1) is damaged.
Cutting blades(s) turn too slowly.	Gear pump (P1) is inefficient (see Testing). Cutting deck motor has internal leakage or malfunctioning cross–over relief valve (see Testing). Cutting deck spindle bearing(s) is (are) damaged.
Cutting units will not lift or lift slowly.	Engine speed is too low. Lift cylinder linkage is binding or broken. Lift arm bushings are binding. Reservoir oil level is low. Charge pump (P2) pressure or flow is insufficient. Charge pump (P2) is damaged. Implement relief valve (in steering control valve) is stuck open. Lift cylinders leak internally. Lift control valve is defective.
Cutting units raise, but will not stay up.	Lift cylinders leak internally. Check valve within the lift control valve leaks.
Steering Problems.	See Sauer/Danfoss Steering Unit Type OSPM Service Manual at the end of this chapter.
Turning steering wheel turns machine in the opposite direction.	Hoses to the steering cylinder are reversed.

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Testing

The most effective method for isolating problems in the hydraulic system is by using hydraulic test equipment such as pressure gauges and flow meters in the circuits during various operational checks (See the Special Tools section in this Chapter).

Before Performing Hydraulic Tests

IMPORTANT: All obvious areas such as oil supply, filter, binding linkages, loose fasteners or improper adjustments must be checked before assuming that a hydraulic component is the source of the problem.

Precautions for Hydraulic Testing

CAUTION

Failure to use gauges with expected pressure (psi) rating as listed in test procedures could result in damage to the gauge and possible personal injury from leaking hot oil.

CAUTION

All testing should be performed by two (2) people. One person should be in the seat to operate the machine and the other should read and record test results.

WARNING

Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Do not use hands to search for leaks; use paper or cardboard. Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and cause serious injury. If fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury. Gangrene may result from such an injury.

1. Clean machine thoroughly before disconnecting or disassembling any hydraulic components. Always keep in mind the need for cleanliness when working on hydraulic equipment. Contamination can cause excessive wear or binding of hydraulic components.

2. Before testing, check control linkages for improper adjustment, binding or broken parts.

3. All hydraulic tests should be made with the hydraulic oil at normal operating temperature.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

4. Put metal caps or plugs on any hydraulic lines left open or exposed during testing or component removal.

5. When using hydraulic tester (pressure and flow), the inlet and the outlet hoses must be properly connected and not reversed to prevent damage to the hydraulic tester or components.

6. Install hydraulic fittings finger tight and far enough to make sure that they are not cross–threaded before tightening them with a wrench.

7. Position tester hoses to prevent rotating machine parts from contacting and damaging the hoses or tester.

8. After connecting test equipment, check oil level in the hydraulic tank to make sure that oil level is correct.

9. When using hydraulic tester (pressure and flow), open tester load valve completely before starting engine to minimize the possibility of damaging components.

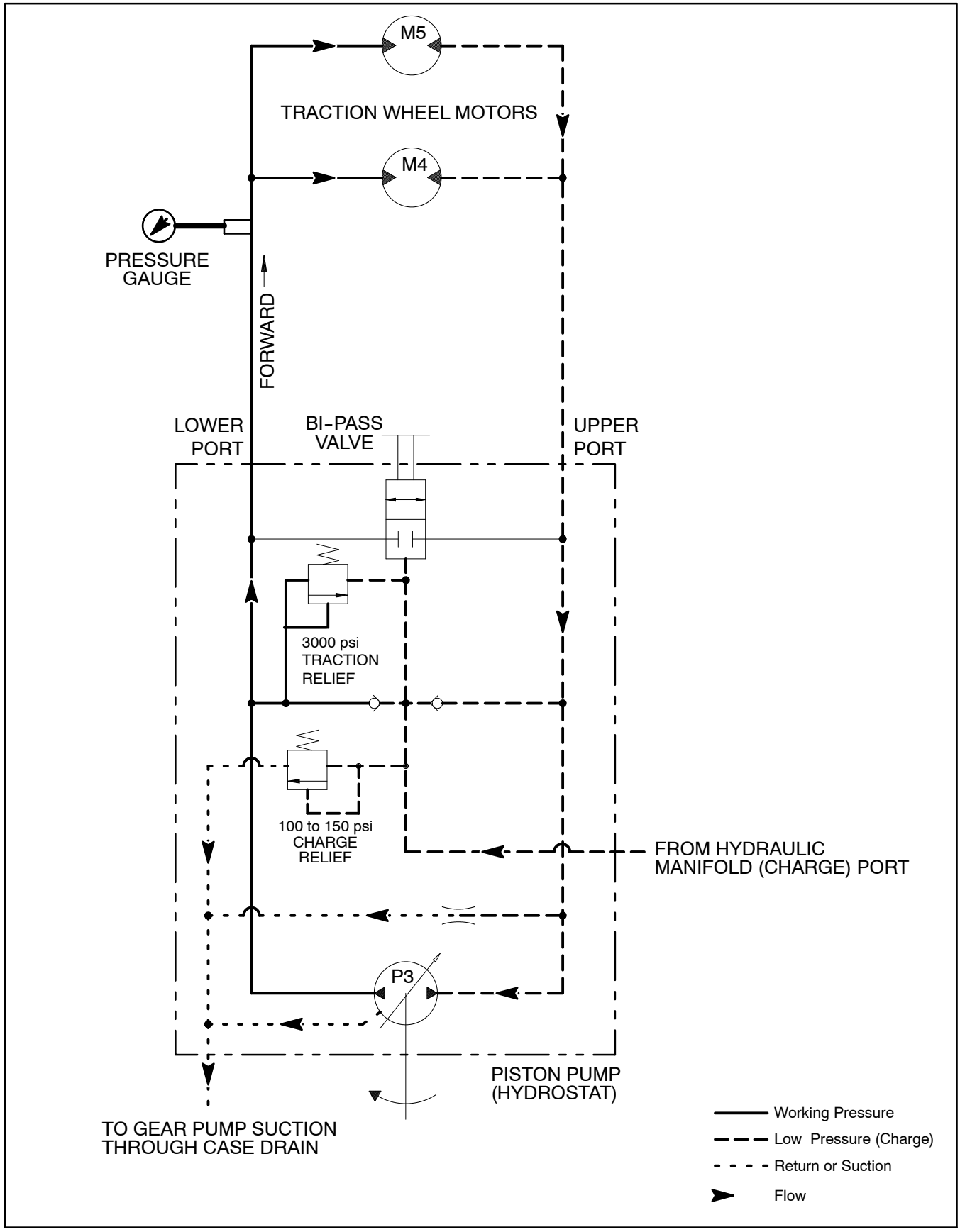
10. The engine must be in good operating condition. Use a phototac when performing a hydraulic test. Engine speed can affect the accuracy of the tester readings. Check actual speed of the pump when performing hydraulic flow tests.

11. If a traction circuit problem exists, consider performing one or more of the following tests: Traction Circuit Working Pressure, Charge Relief Valve Pressure, Piston Pump (P3) Flow & Traction Relief Pressure and/or Wheel Motor Efficiency Tests.

12. If a cutting circuit problem exists, consider performing one or more of the following tests: Cutting Deck Circuit Pressure, Manifold Relief Valve (R1) Pressure, Logic (Counterbalance) Valve (LC1) Pressure, Gear Pump (P1) Flow and/or Deck Motor Efficiency Tests.

13. If a steering or lift circuit problem exists, consider performing one or more of the following tests: Steering and Lift Relief Pressure, Gear Pump (P2) Flow and/or Steering Control Valve Tests.

Traction Circuit Working Pressure Test (Using Pressure Gauge)



Procedure for Traction Circuit Working Pressure Test:

1. Make sure hydraulic oil is at normal operating temperature. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off.

2. Read Precautions for Hydraulic Testing.

3. Make sure that traction pedal is adjusted to the neutral position (see Traction Unit Operator's Manual).

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

4. Remove plug from hydraulic tube connected to front wheel motors (Fig. 16). Connect test gauge with an attached hydraulic hose to the hydraulic tube opening. Make sure hose is long enough so the operator can read gauge while driving the machine.

5. Start engine and move throttle to full speed (3050 ± 50 RPM).

6. Drive machine in the **forward** direction. Observe test gauge:

   A. Pressure while transporting the machine over a flat, level surface should be about **500 PSI**.

   B. Pressure driving the machine up a hill should be about **2500 PSI** but can reach relief settings (3000 PSI).

   C. Pressure while mowing should range between **1000 to 2000 PSI** and will vary with terrain conditions.

7. Release traction pedal and turn off machine. Record test results.

8. If specification is not met, the hydrostat needs to be repaired or replaced as necessary.

9. Relieve hydraulic system pressure (See Relieving Hydraulic System Pressure in the General Information section). Disconnect test gauge and hose from the hydraulic tube. Install plug into tube opening.

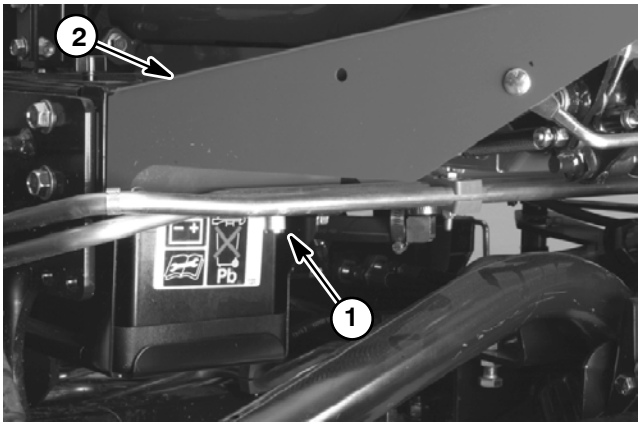
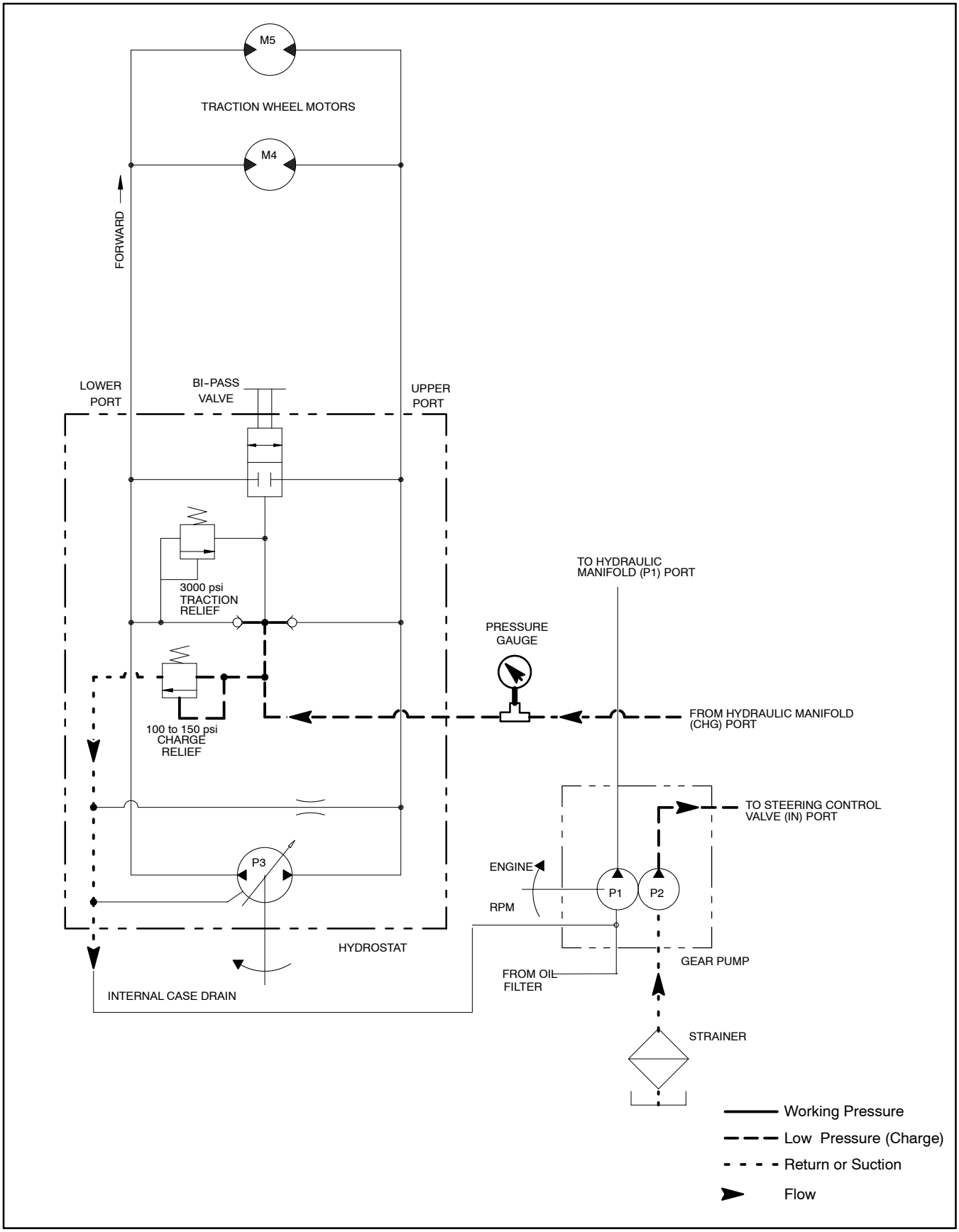


Figure 16

1. Hydraulic tube with plug **2. Floor plate**

Charge Relief Valve Pressure Test (Using Pressure Gauge)



Procedure for Charge Relief Valve Pressure Test:

1. Make sure hydraulic oil is at normal operating temperature.

2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

3. Read Precautions for Hydraulic Testing.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

4. Disconnect hose to the rear 90º hydraulic fitting on the piston pump coming from the hydraulic manifold port (CHG). Connect T−connector and hydraulic pressure gauge to the fitting and hose connection.

5. Make sure that traction pedal is in neutral and the parking brake is engaged.

6. Start engine and operate engine at full speed (3050 ± 50 RPM).

7. Pressure gauge should read from **100 to 150 PSI**. Record test result.

8. If charge relief pressure specification is not met, consider the following:

A. The piston pump charge relief valve is faulty. Repair or replace the piston pump charge relief valve (see Piston Pump Service in the Service and Repairs section).

B. Gear pump (P2) is faulty (steering and lift circuits are also affected).

9. A dynamic charge pressure test can be performed as follows:

A. With T−connector and hydraulic pressure gauge still connected, sit in the operator seat and press the traction pedal to forward.

B. While machine is moving, monitor the charge pressure reading on the pressure guage.

C. The charge pressure should drop no more than 15% from initial test reading (Step 7 above) as the machine is moving. A pressure drop of more than 15% indicates a traction circuit leak (e.g. a worn or damaged piston pump and/or wheel motor).

NOTE: If charge pressure is good under no load, but drops below specification when under traction load, the piston pump and/or wheel motor(s) should be suspected of wear. When a pump and/or motor is worn or damaged, the charge pump is not able to keep up with internal leakage in the traction circuit.

10. Stop machine and shut off engine.

11. Relieve hydraulic system pressure (See Relieving Hydraulic System Pressure in the General Information section). Disconnect gauge and T−connection from the 90º hydraulic fitting and hose connection. Reconnect hose to the hydrostat.

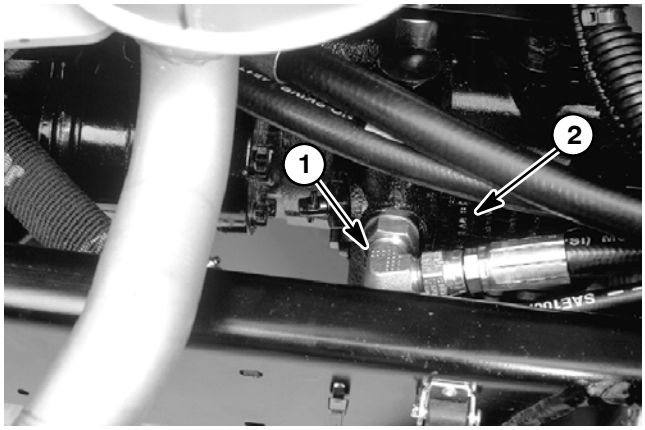
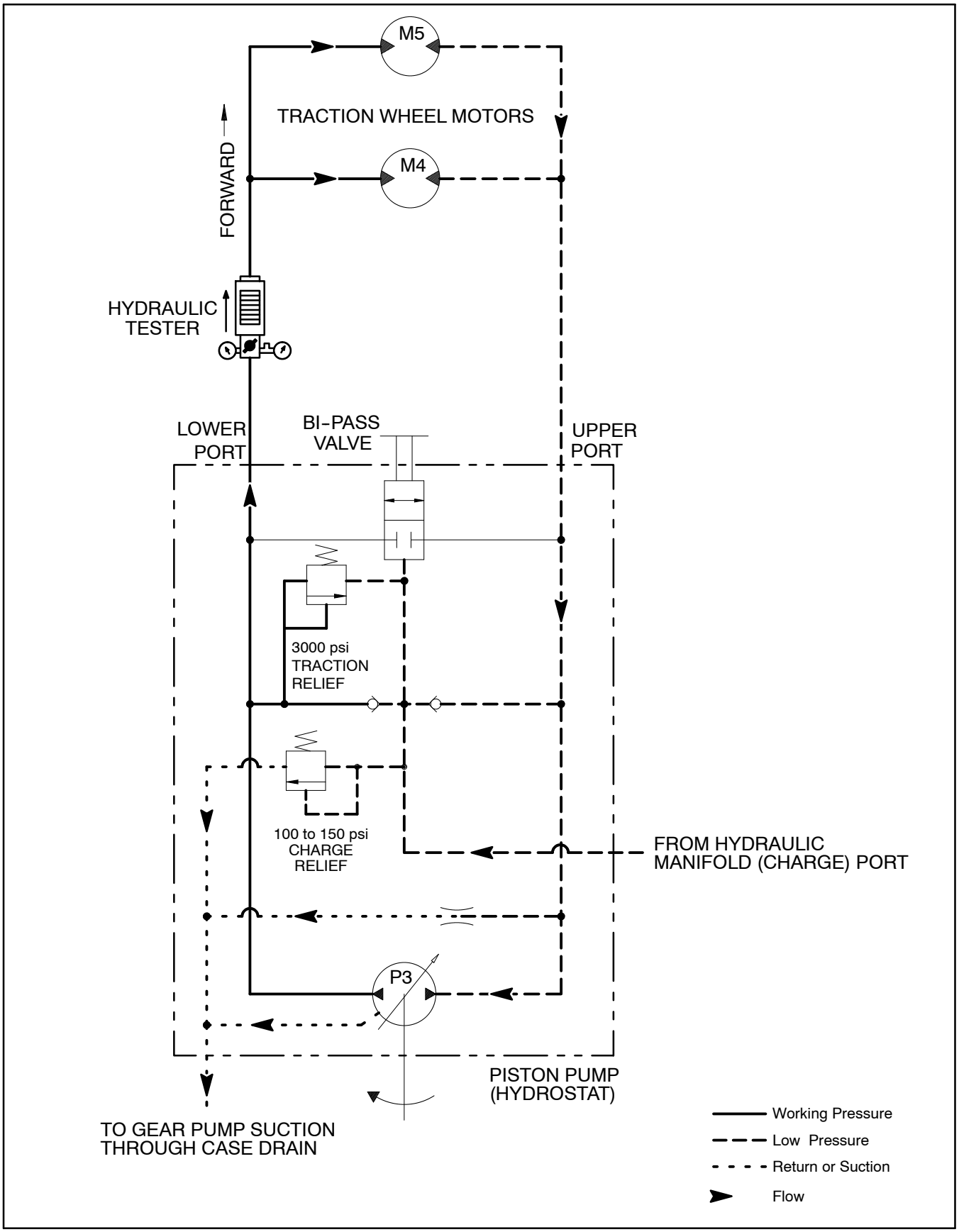


Figure 17

1. **90º hydraulic fitting**
2. **Piston pump**

Piston Pump (P3) Flow and Traction Relief Pressure Test (Using Tester with Pressure Gauges and Flow Meter)



Procedure for Piston Pump (P3) Flow and Traction Relief Pressure Test:

1. Make sure hydraulic oil is at normal operating temperature. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off.

2. Read Precautions for Hydraulic Testing.

3. Make sure that traction pedal is adjusted to the neutral position (see Traction Unit Operator's Manual).

CAUTION

One front wheel will be off the ground during testing. Make sure machine is supported so it will not move and accidentally fall to prevent injuring anyone under machine.

4. Block up one front traction wheel off the ground to allow flow through the traction circuit; disconnect brake linkage to the raised front wheel (see Adjust Brakes in the Adjustments section of Chapter 7 – Chassis).

5. Chock remaining front wheel to prevent movement of the machine.

6. Attach a heavy chain to the rear of the machine frame and something immovable in the shop.

7. Make sure parking brake is on to keep the wheel on the ground from rotating.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

8. Disconnect hose from the lower hydraulic fitting on the engine side of the hydrostat (Fig. 18).

9. Install hydraulic tester (pressure and flow) in series with the pump and the disconnected hose. Make sure the tester flow control valve is fully open.

10. Start engine and move throttle to full speed (3050 ± 50 RPM).

CAUTION

During testing, the front wheel on the ground will be trying to move the machine forward.

11. Slowly push traction pedal fully to **forward** position.

12. Verify traction relief valve setting by slowly closing flow control valve on tester. System pressure should be **3000 PSI** as the relief valve lifts. Release traction pedal and open tester flow control valve fully.

13. If relief pressure specification is not met, consider the following:

A. The traction belt may be worn or slipping.

B. The traction relief valve leaks or is faulty.

C. The hydrostat needs to be repaired or replaced.

14. If the traction relief valve tests properly, verify piston pump (P3) flow as follows:

A. Slowly push traction pedal in **forward** direction until pressure gauge reads **1000 PSI**. Verify with a phototac that the **pump speed** is **2350 RPM** (engine speed approximately 2450 RPM).

B. Observe flow gauge. TESTER READING should be approximately **12.5 GPM**.

15. Release traction pedal and turn off machine. Record test results.

NOTE: If charge pressure is good under no load, but drops below specification when under traction load, the piston pump and/or wheel motor(s) should be suspected of wear. When a pump and/or motor is worn or damaged, the charge pump is not able to keep up with internal leakage in the traction circuit (See Charge Relief Valve Pressure Test in this section).

16. If specifications are not met, the hydrostat needs to be repaired or replaced as necessary.

17. Relieve hydraulic system pressure (See Relieving Hydraulic System Pressure in the General Information section). Disconnect tester from hydraulic fitting and hose. Reconnect hose to pump connection.

18. Connect brake linkage to wheel (see Adjust Brakes in the Adjustments section of Chapter 7 – Chassis).

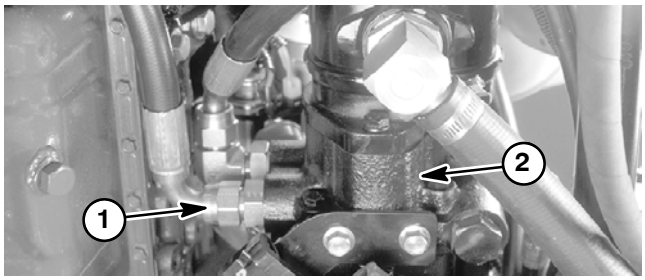
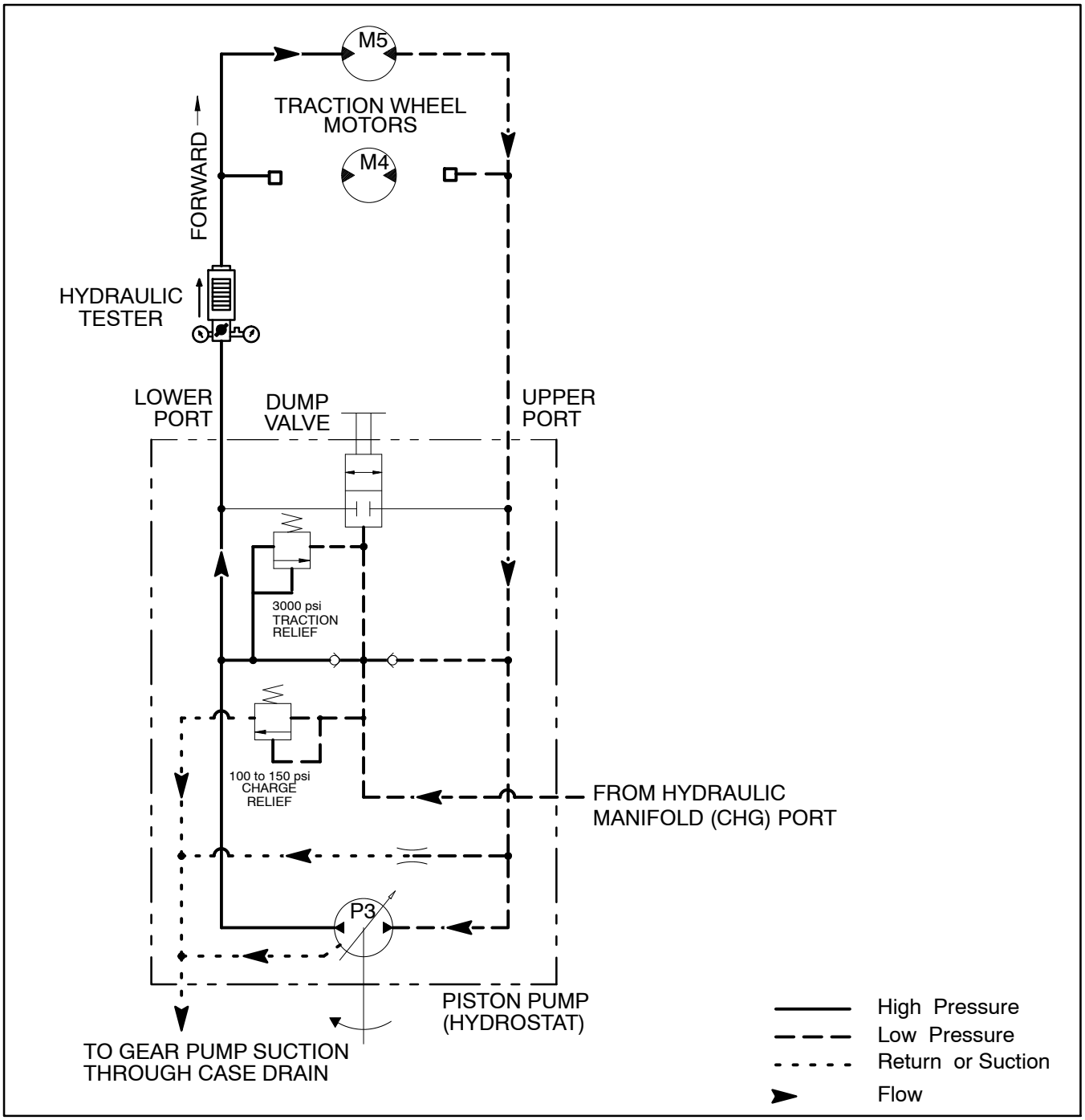


Figure 18

1. **Lower hydraulic fitting** 2. **Piston pump**

Wheel Motor Efficiency Test (Using Tester with Pressure Gauges and Flow Meter)



NOTE: Over a period of time, a wheel motor can wear internally. A worn motor may by-pass oil to its case drain causing the motor to be less efficient. Eventually, enough oil loss will cause the wheel motor to stall under heavy load conditions. Continued operation with a worn, inefficient motor can generate excessive heat, cause damage to seals and other components in the hydraulic system and affect overall machine performance.

Procedure for Wheel Motor Efficiency Test:

1. Make sure hydraulic oil is at normal operating temperature. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

3. Read Precautions for Hydraulic Testing.

4. Make sure that traction pedal is adjusted to the neutral position (see Adjust Traction Drive for Neutral in the Adjustments Section).

5. Attach a heavy chain to the rear of the machine frame and an immovable object to prevent the machine from moving during testing.

6. Chock front wheel being tested to prevent rotation of the wheel. Make sure parking brake is on.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

7. Disconnect hydraulic lines from front wheel motor that is **not** being tested. Cap disconnected hydraulic lines and plug ports in wheel motor to prevent contamination.

8. Disconnect hose from the lower hydraulic fitting on the bottom of the hydrostat (Fig. 19).

NOTE: An alternate testing location would be at the hydraulic hose connection to the hydraulic tube under the left floor plate.

9. Install hydraulic tester (pressure and flow) in series with the pump and the disconnected hose. Make sure the tester flow control valve is fully open.

10. Start engine and move throttle to full speed (3050 ± 50 RPM).

CAUTION

Use extreme caution when performing test. The front tire on the ground will be trying to move the machine forward.

11. Slowly push traction pedal in **forward** direction until **1000 PSI** is displayed on the tester pressure gauge.

12. Motor internal leakage will be shown on flow meter in GPM. Flow should be **less than 1.5 GPM** for the tested wheel motor.

13. If specifications are not met, the tested wheel motor needs to be repaired or replaced as necessary.

14. If remaining front wheel motor requires testing, complete steps 5 to 14 for the remaining motor.

15. Relieve hydraulic system pressure (See Relieving Hydraulic System Pressure in the General Information section). Disconnect tester from hydraulic fitting and hose. Reconnect hose to pump connection.

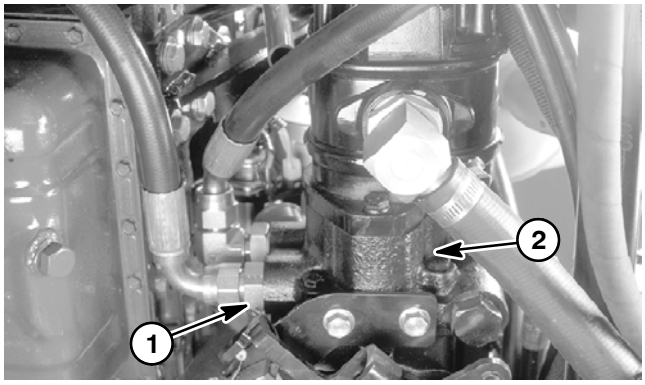
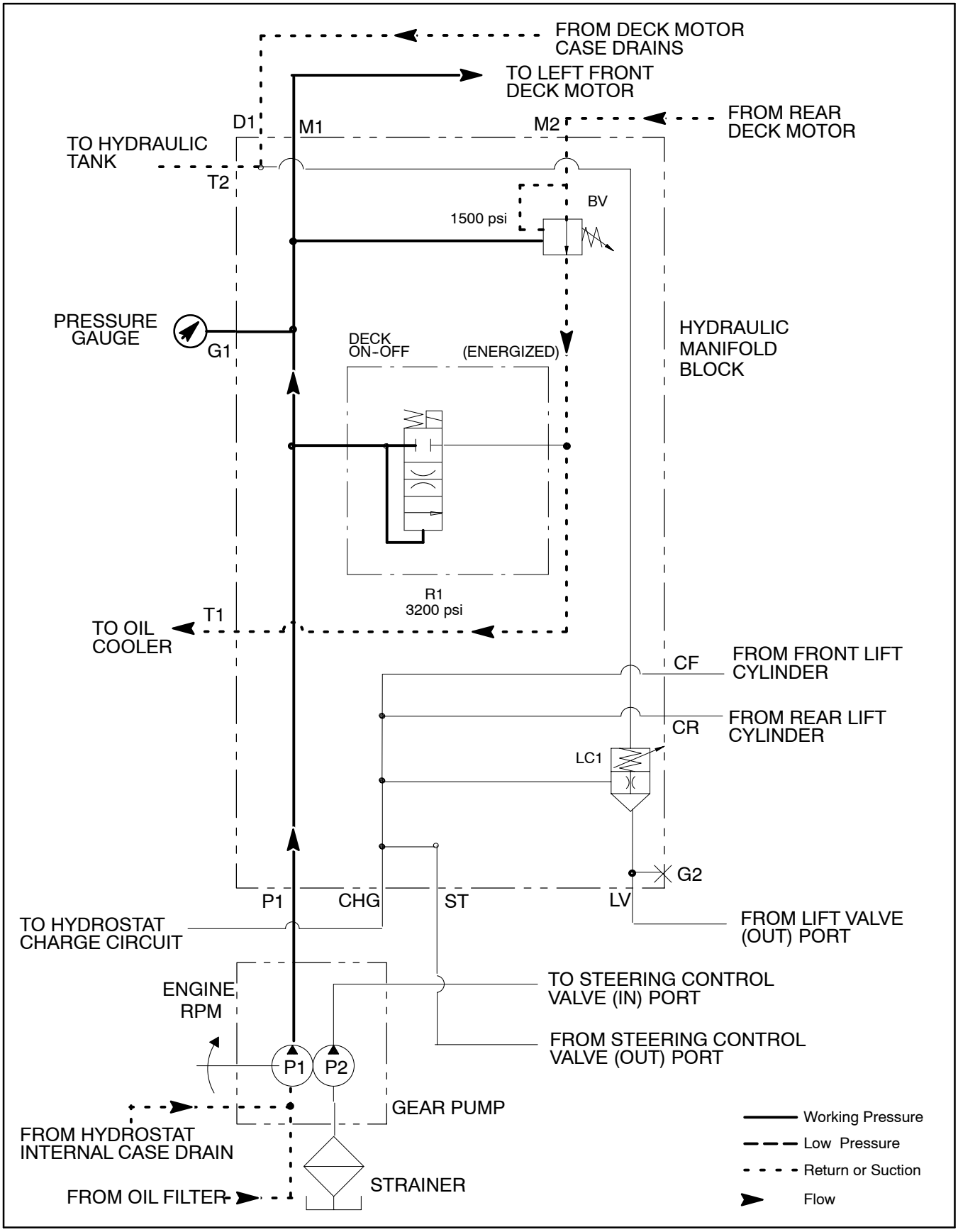


Figure 19

1. **Lower hydraulic fitting** 2. **Piston pump**

Cutting Deck Circuit Pressure Test (Using Pressure Gauge)



Procedure for Cutting Deck Circuit Pressure Test:

1. Make sure hydraulic oil is at normal operating temperature.

2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

3. Read Precautions for Hydraulic Testing.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

4. Remove plug from hydraulic manifold port (G1).

5. Install hydraulic pressure gauge with hydraulic hose attached to the manifold port (G1).

CAUTION

Keep away from decks during test to prevent personal injury from the cutting blades.

6. Start engine and move throttle to full speed (3050 ± 50 RPM). Engage the cutting units.

7. Watch pressure gauge carefully while mowing with the machine.

8. Cutting circuit pressure should be from **1000 to 1500 PSI** and will vary depending on mowing conditions.

9. Disengage cutting units. Shut off engine. Record test results.

10. Relieve hydraulic system pressure (See Relieving Hydraulic System Pressure in the General Information section). Disconnect pressure gauge with hose from manifold block. Reconnect plug to the hydraulic manifold port (G1).

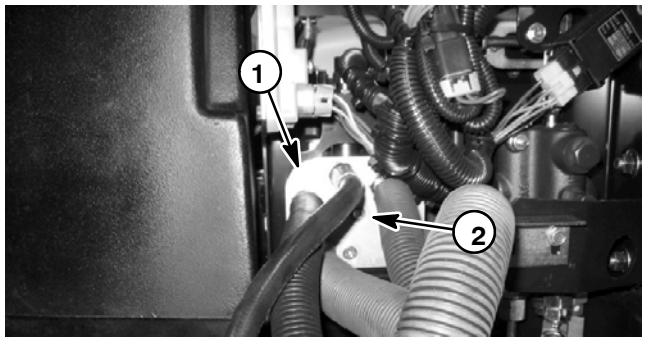


Figure 20

1. **Hydraulic manifold** 2. **Manifold port (G1)**

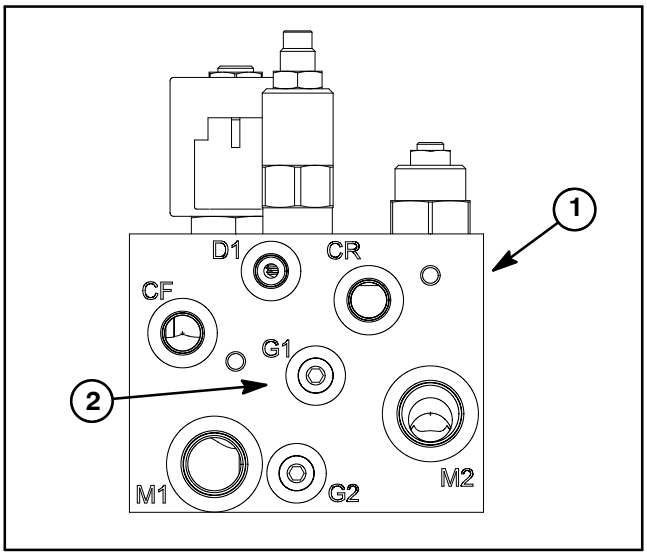
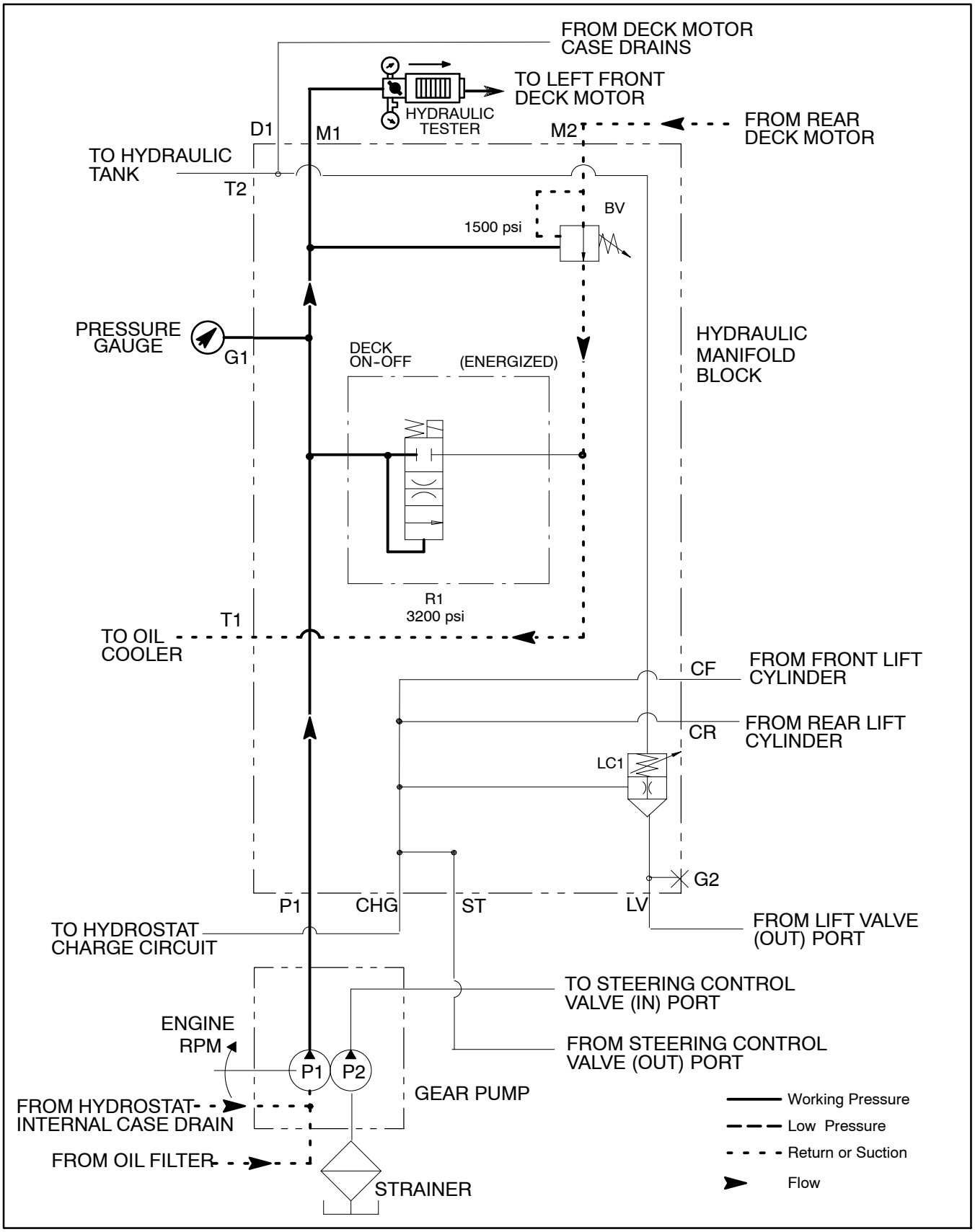


Figure 21

1. **Hydraulic manifold** 2. **Manifold port (G1)**

Manifold Relief Valve (R1) Pressure Test (Using Pressure Gauge and Tester with Pressure Gauges and Flow Meter)



Procedure for Manifold Relief Valve (R1) Pressure Test:

1. Make sure hydraulic oil is at normal operating temperature.

2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

3. Read Precautions for Hydraulic Testing.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

4. Disconnect hose connection from hydraulic fitting on manifold port (M1) (Figure 22).

NOTE: An alternative to using manifold port (M1) would be to disconnect the inlet hydraulic hose to the front, left deck motor. The motor inlet is opposite from the relief valve on the motor (Figure 24).

5. Install hydraulic tester (pressure and flow) in series with the hose and hydraulic fitting. Make sure the flow control valve on tester is fully open.

CAUTION

Keep away from decks during test to prevent personal injury from the cutting blades.

6. Start engine and move throttle to full speed (3050 ± 50 RPM). Engage the cutting units.

7. Watch pressure gauge carefully while slowly closing the flow control valve to fully closed.

8. System pressure should be from **3350 to 3600 PSI** as the relief valve lifts.

A. If specification is **not** met, shut off engine and clean or replace solenoid cartridge valve (R1) valve (see Hydraulic Manifold Service in the Service and Repairs section). Return to step 5.

B. If this specification is met, proceed to step 9.

9. Disengage cutting units. Shut off engine. Record test results.

10. Relieve hydraulic system pressure (See Relieving Hydraulic System Pressure in the General Information section). Disconnect tester from manifold and hose. Reconnect hydraulic hose that was disconnected for test procedure.

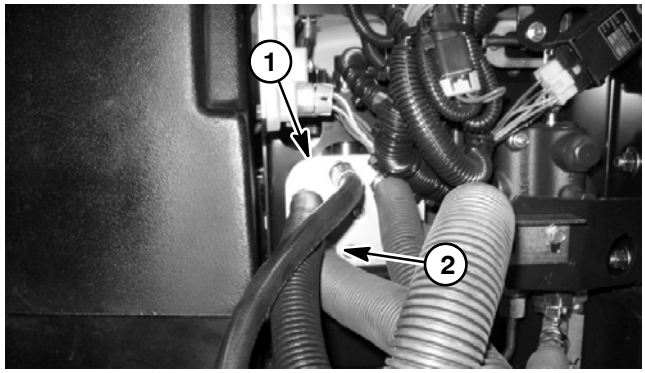


Figure 22

1. **Hydraulic manifold** 2. **Manifold port (M1)**

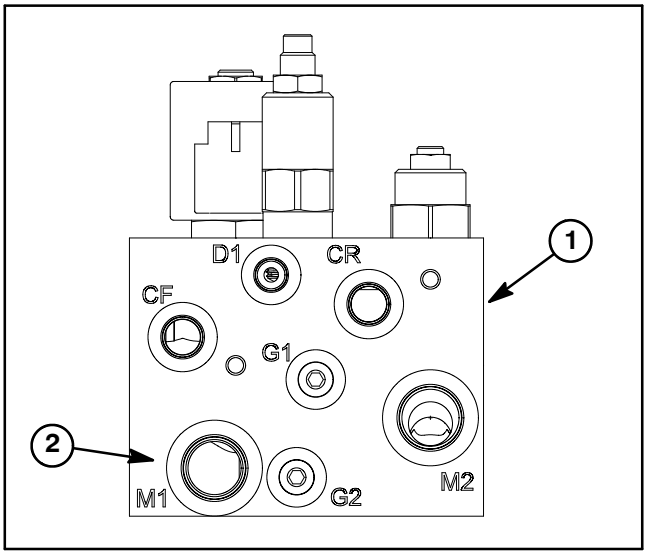


Figure 23

1. **Hydraulic manifold** 2. **Manifold port (M1)**

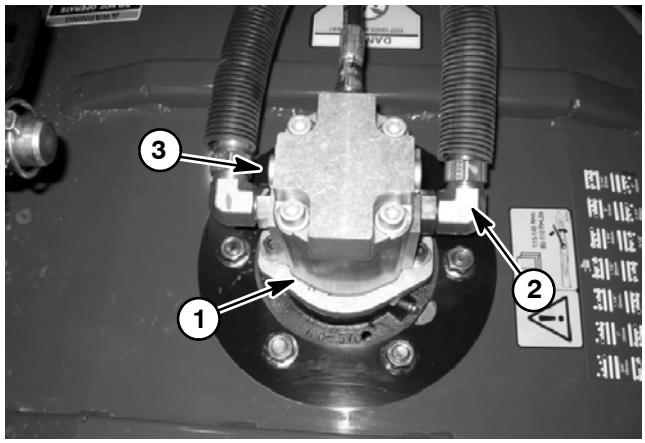
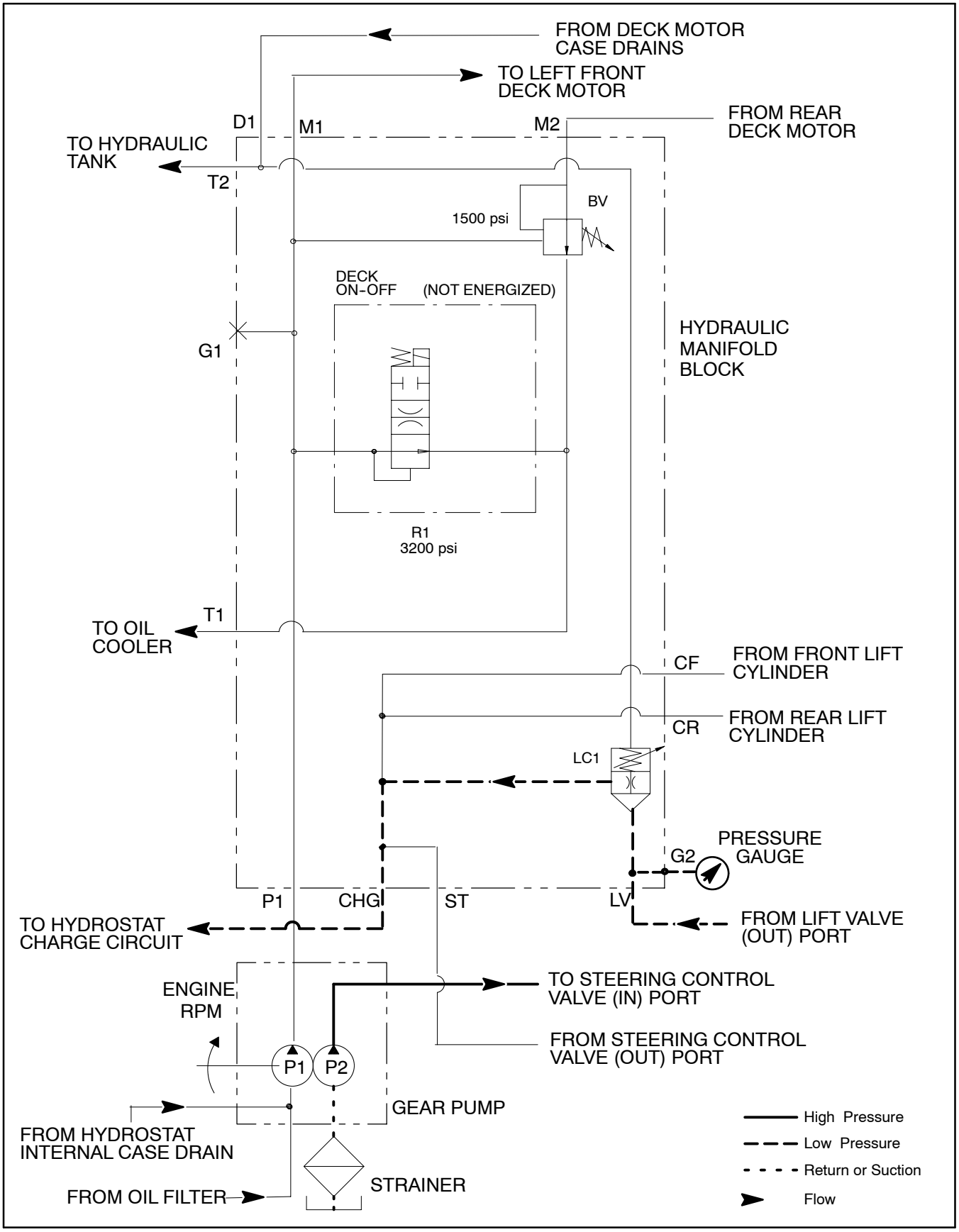


Figure 24

1. **Hydraulic deck motor** 3. **Relief valve**
2. **Inlet hose**

Logic (Counterbalance) Valve (LC1) Pressure Test (Using Pressure Gauge)



Procedure for Logic (Counterbalance) Valve (LC1) Pressure Test:

NOTE: If the counterbalance system is functioning, the machine should normally settle slightly when the engine is started.

1. Make sure hydraulic oil is at normal operating temperature.

2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

3. Read Precautions for Hydraulic Testing.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

4. Remove plug from hydraulic manifold port (G2) (Fig. 25).

5. Install hydraulic pressure gauge with hydraulic hose attached to port (G2).

CAUTION

Keep away from decks during test to prevent personal injury from the cutting blades.

6. Start engine and move throttle to full speed (3050 ± 50 RPM). **Do not engage or raise the cutting units.**

7. The standard counterbalance pressure should be **250 PSI** with a range of 180 to 300 psi.

8. If necessary, adjustment of the Logic valve (LC1) can be performed as follows:

NOTE: Do not remove the Logic valve from the hydraulic manifold for adjustment.

A. Remove hex cap from logic valve (Fig. 26).

B. Loosen lock nut.

C. To **increase** pressure setting, turn the adjustment shaft on the valve in a clockwise direction. A 1/8 turn on the shaft will make a measurable change in counterbalance pressure.

D. To **decrease** pressure setting, turn the adjustment shaft on the valve in a counterclockwise direction. A 1/8 turn on the shaft will make a measurable change in counterbalance pressure.

E. Tighten lock nut. Check counterbalance pressure (steps 6 and 7) and readjust as needed.

F. Replace hex cap to Logic valve (LC1).

9. Shut off engine.

10. Relieve hydraulic system pressure (See Relieving Hydraulic System Pressure in the General Information section). Disconnect test gauge with hose from manifold block. Install plug into hydraulic manifold port (G2) and torque plug 120 in-lb (13.6 N-m).

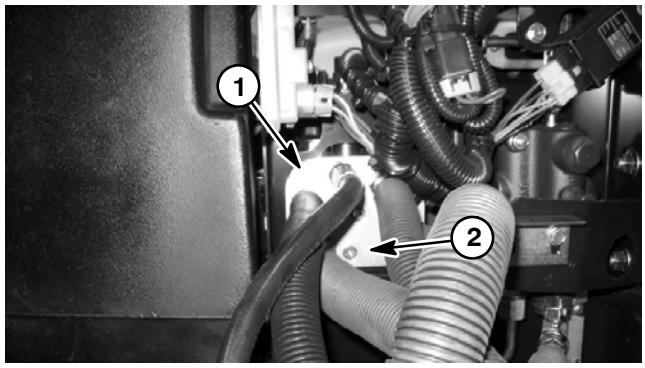


Figure 25

1. Hydraulic manifold
2. Manifold port (G2)

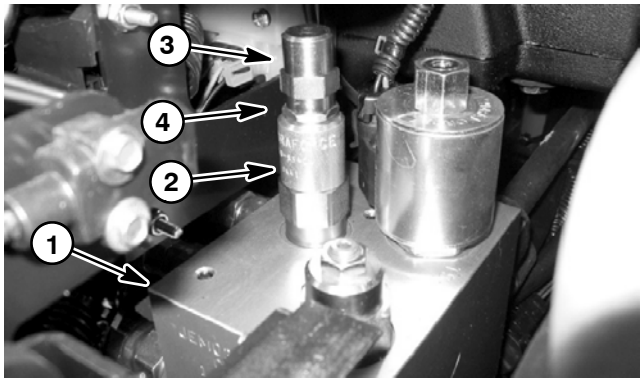
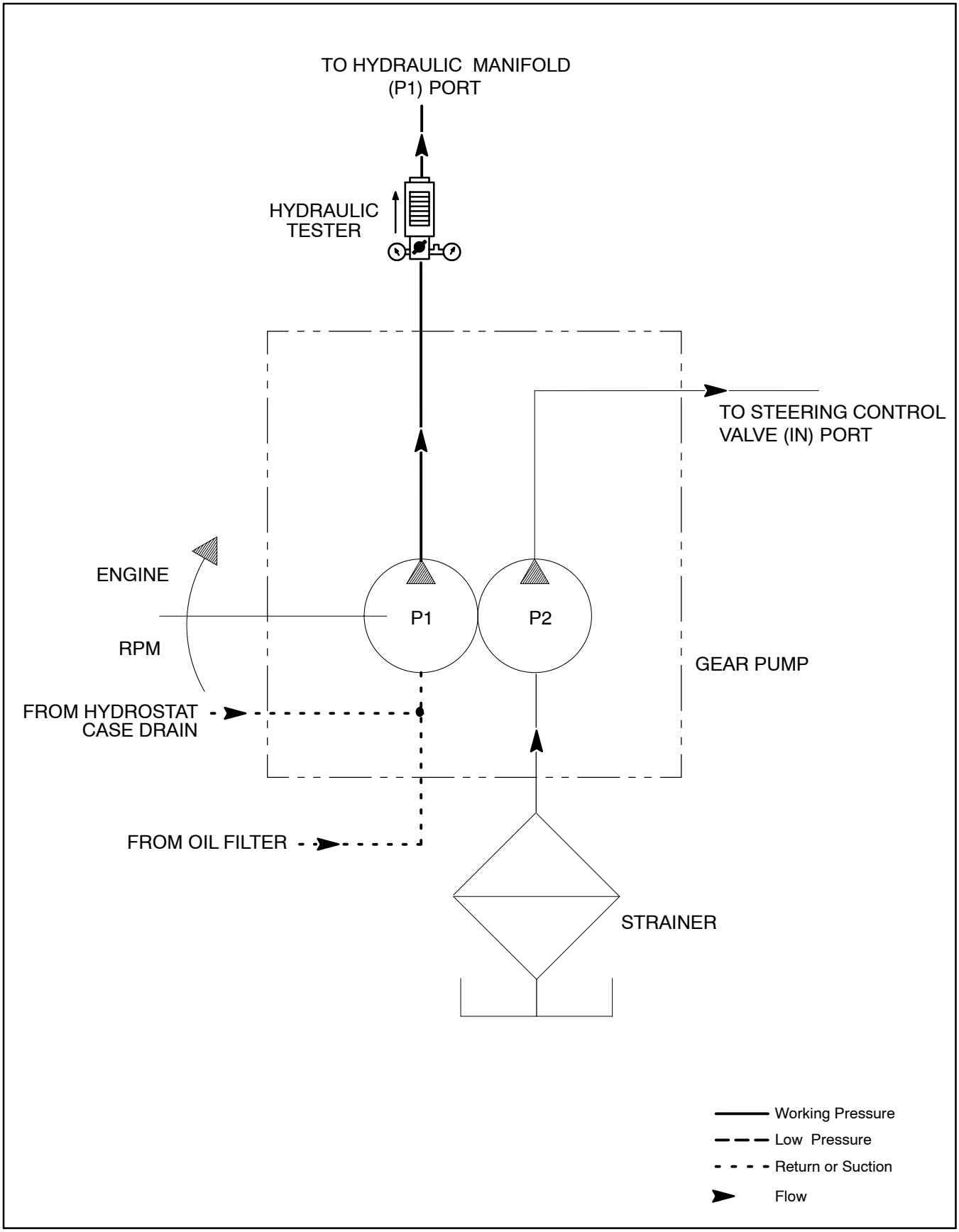


Figure 26

1. Manifold assembly
2. Logic valve (LC1)
3. Hex cap
4. Lock nut

Gear Pump (P1) Flow Test (Using Tester with Pressure Gauges and Flow Meter)



Procedure for Gear Pump (P1) Flow Test:

NOTE: Over a period of time, the gears and wear plates in the pump can wear. A worn pump will by pass oil and make the pump less efficient. Eventually, enough oil loss will occur to cause the cutting unit motors to stall under heavy cutting conditions. Continued operation with a worn, inefficient pump can generate excessive heat and cause damage to the seals and other components in the hydraulic system.

1. Make sure hydraulic oil is at normal operating temperature.

2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

3. Read Precautions for Hydraulic Testing.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

4. Disconnect hose connection on the gear pump (P1) leading to port (P1) on the hydraulic manifold (Fig. 27).

5. Install hydraulic tester (pressure and flow) in series with the gear pump and the disconnected hose leading to port (P1) on the hydraulic manifold.

6. Make sure the flow control valve on the tester is fully open.

7. Start engine and move throttle to full speed (3050 ± 50 RPM). **Do not engage the cutting units**.

IMPORTANT: In this test, the hydraulic tester is positioned before the manifold relief valve. Pump damage can occur if the oil flow is fully restricted by fully closing the tester flow control valve. Do not close tester valve fully when performing test.

8. Watch tester pressure gauge carefully while slowly closing the flow control valve until **2000 PSI** is obtained. Do not close tester load valve fully. Verify with a phototac that the **pump speed** is **3100 RPM** while maintaining 2000 PSI.

9. Flow indication should be **11.8 GPM** minimum.

10. Shut off engine. Record test results.

11. If flow was less than **11.8 GPM** or a pressure of **2000 PSI** cannot be obtained, check for restriction in the pump intake line. If line is not restricted, remove gear pump (P1) and repair or replace as necessary.

12. Relieve hydraulic system pressure (See Relieving Hydraulic System Pressure in the General Information section). Disconnect tester from gear pump fitting and hose. Reconnect hose to the pump.

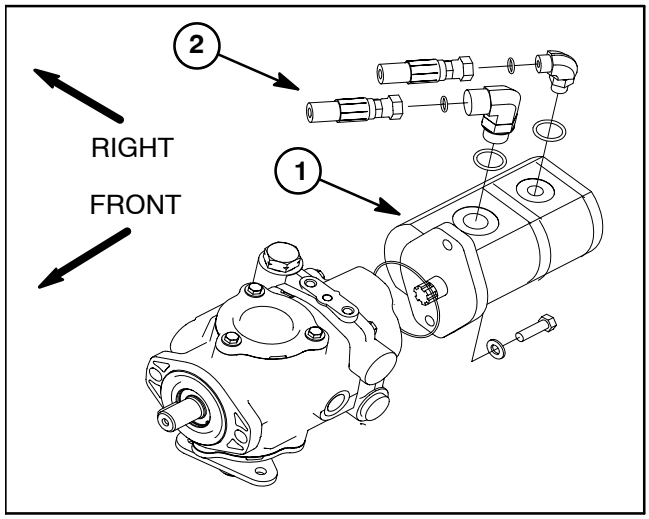
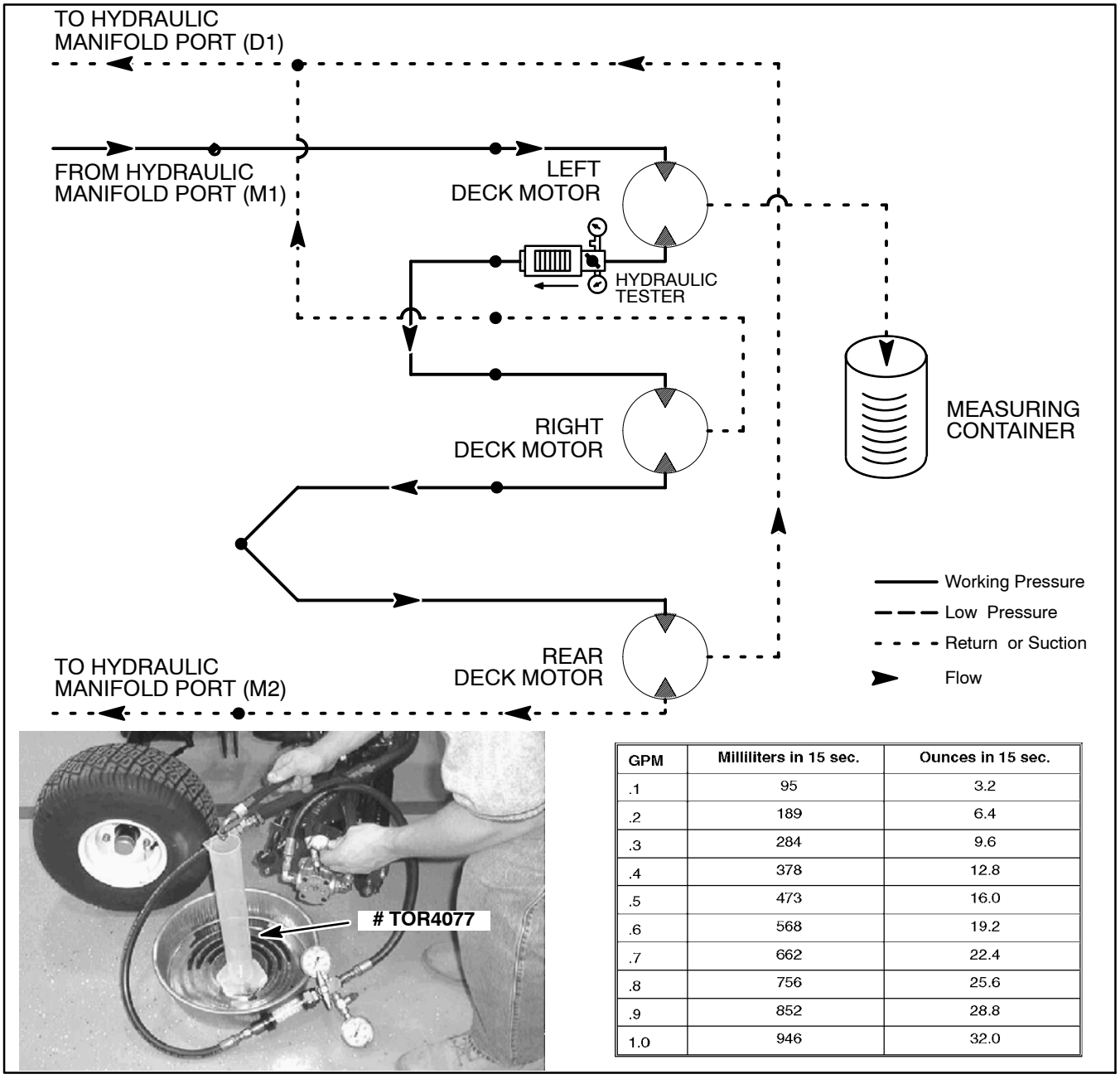


Figure 27

1. **Gear pump (P1)**
2. **To hydraulic manifold**

Deck Motor Efficiency - Case Drain Test (Using Tester with Pressure Gauges and Flow Meter)



GPM	Milliliters in 15 sec.	Ounces in 15 sec.
.1	95	3.2
.2	189	6.4
.3	284	9.6
.4	378	12.8
.5	473	16.0
.6	568	19.2
.7	662	22.4
.8	756	25.6
.9	852	28.8
1.0	946	32.0

NOTE: Over a period of time, a deck motor can wear internally. A worn motor may by-pass oil to its case drain causing the motor to be less efficient. Eventually, enough oil loss will cause the deck motor to stall under heavy cutting conditions. Continued operation with a worn, inefficient motor can generate excessive heat, cause damage to seals and other components in the hydraulic system and affect quality of cut.

NOTE: One method to identify a possibly bad deck motor is to have another person observe the machine while mowing in dense turf. A bad motor will run slower, produce fewer clippings and could cause a different appearance in the turf.

Procedure for Deck Motor Efficiency - Case Drain Test:

1. Make sure hydraulic oil is at normal operating temperature.

2. Remove blades from all cutting decks (see Cutting Unit Operator's Manual).

3. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

4. Read Precautions for Hydraulic Testing.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

NOTE: The deck motors are connected in series. To isolate a faulty motor, all three motors in the cutting circuit may have to be tested by starting with the upstream motor first.

5. For the suspected bad deck motor, disconnect return hose from the motor. **Note:** the return hose is on the motor side that includes the relief valve (Fig. 28).

6. Install hydraulic tester (pressure and flow) in series with the motor and the disconnected return hose. Make sure the tester flow control valve is fully open.

7. Disconnect hose from deck motor case drain at the bulkhead T-fitting (Fig. 29). Plug the T-fitting. Place open end of disconnected case drain hose into a drain pan.

8. One person should sit on the seat and operate the machine while another person reads the tester and measures deck motor case drain leakage. Make sure traction pedal is in **NEUTRAL**. Start engine and move the throttle to full speed (3050 $\pm$ 50 RPM).

CAUTION

Keep away from decks during test to prevent personal injury from rotating parts.

9. Engage decks by positioning the PTO switch to the **ENGAGE** position. While watching hydraulic tester pressure gauge, slowly close flow control valve until a pressure of **1200 PSI** is obtained.

10. After achieving **1200 PSI**, place disconnected motor case drain hose into a container graduated in ounces or milliliters (e.g. Toro #TOR4077) and collect hydraulic fluid for **15** seconds. After **15** seconds, remove hose end from container.

11. Stop cutting units by positioning the PTO switch to the **DISENGAGE** position. Stop engine.

12. Identify amount of oil collected in the container. Record test results.

13. If flow was greater than **22.4 ounces (662 milliliters)**, repair or replace the tested deck motor.

14. Relieve hydraulic system pressure (See Relieving Hydraulic System Pressure in the General Information section). Disconnect tester from motor and hose. Reconnect hydraulic hoses.

15. Repeat test with other deck motors as needed.

16. Install cutting blades after testing is completed (see Cutting Unit Operator's Manual).

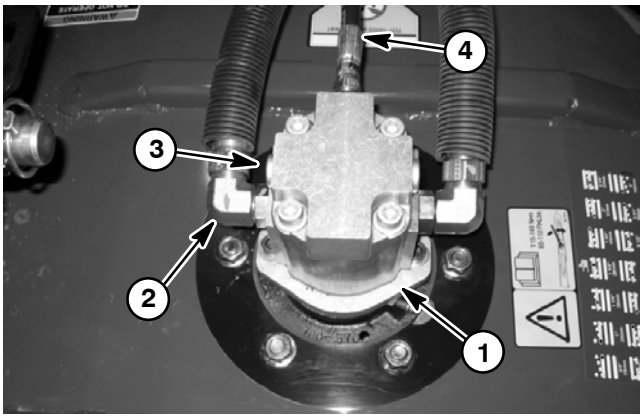


Figure 28

1. **Deck motor**
2. **Return line**
3. **Relief valve**
4. **Case drain hose**

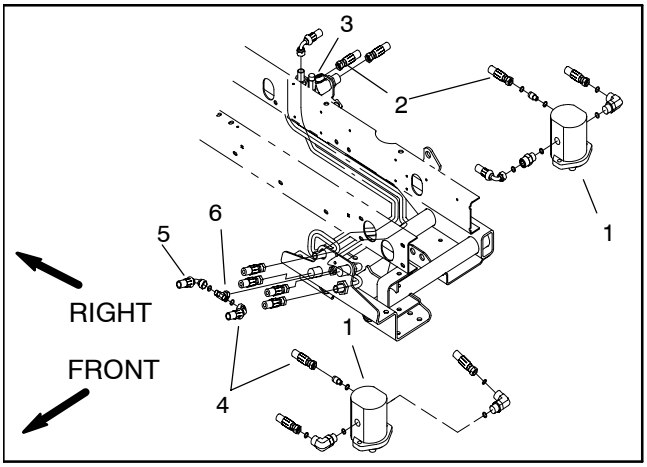
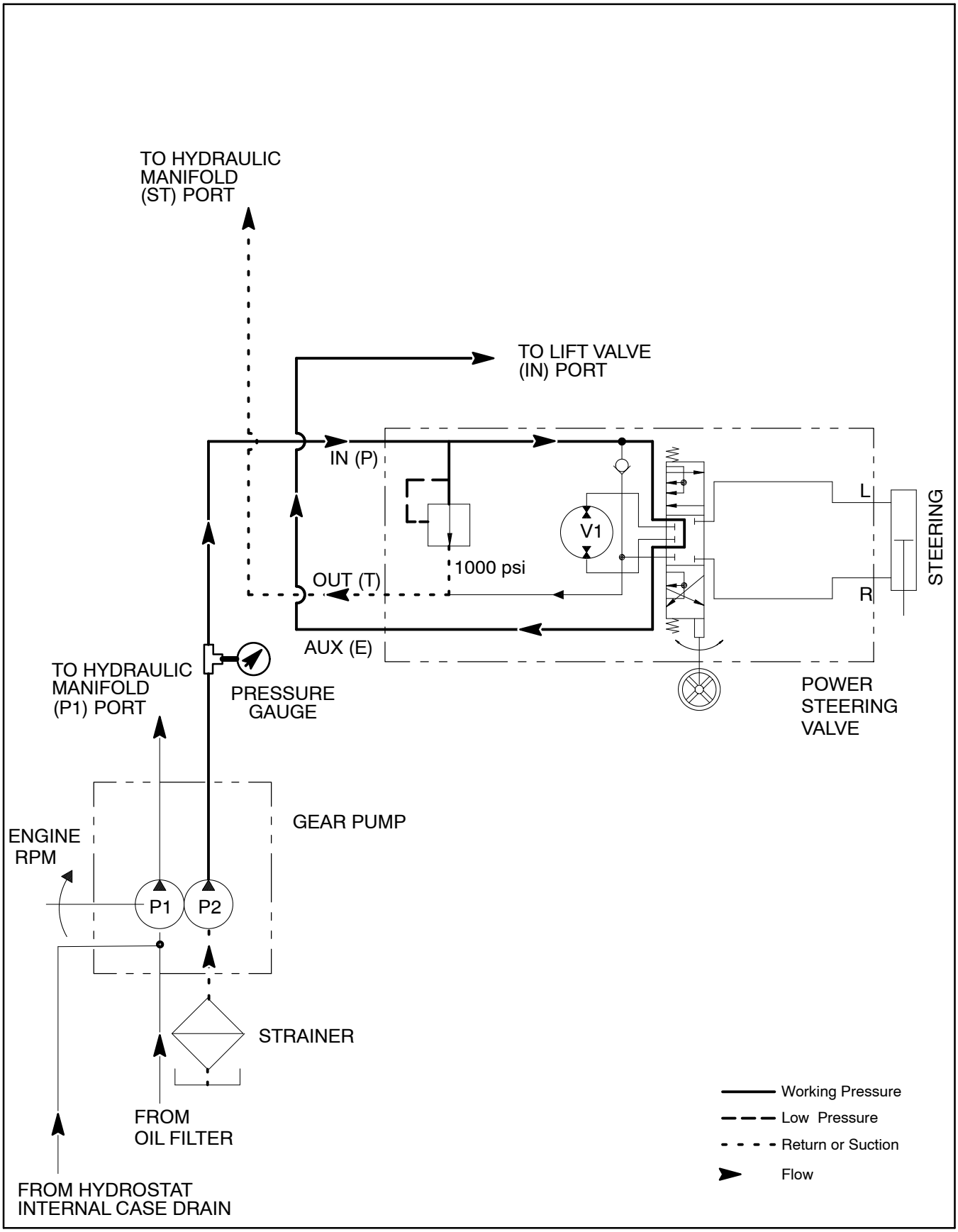


Figure 29

1. **Deck motor**
2. **Rear case drain hose**
3. **Rear T-fitting**
4. **Front LH case drain**
5. **Front RH case drain**
6. **Front T-fitting**

Steering and Lift Relief Pressure Test (Using Pressure Gauge)



Procedure for Steering and Lift Relief Pressure Test:

1. Make sure hydraulic oil is at normal operating temperature.

2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

3. Read Precautions for Hydraulic Testing.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

4. Disconnect hose connection on gear pump (P2) leading to the steering control valve (Fig. 30).

5. Install T−connector with hydraulic pressure gauge in series with the discharge of the gear pump and the disconnected hose leading to the steering control valve.

6. Make sure steering wheel is positioned so the rear wheel points directly ahead.

7. Start engine and move throttle to full speed (3050 ± 50 RPM).

IMPORTANT: Do not allow pressure to exceed 1500 PSI.

IMPORTANT: Hold steering wheel at full lock only long enough to get a system pressure reading. Holding the steering wheel against the stop for an extended period may damage the steering control valve.

8. Watch pressure gauge carefully while turning the steering wheel completely in one direction and holding.

9. System pressure should be from **845** to **995 PSI** as the relief valve lifts. Return steering wheel to the center position.

10. Shut off engine. Record test results.

11. If specification is **not** met, repair or replace steering control valve (relief valve in steering control valve is not replaceable).

12. Relieve hydraulic system pressure (See Relieving Hydraulic System Pressure in the General Information section). Disconnect T−connector with test gauge from pump connection and hose. Reconnect hydraulic hose to gear pump (P2).

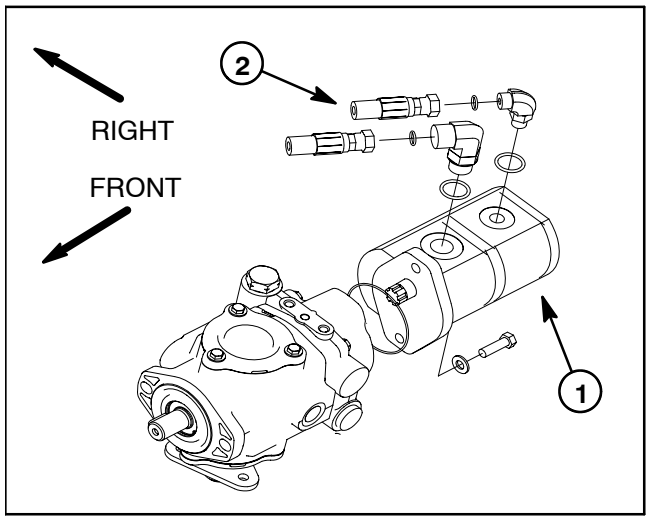
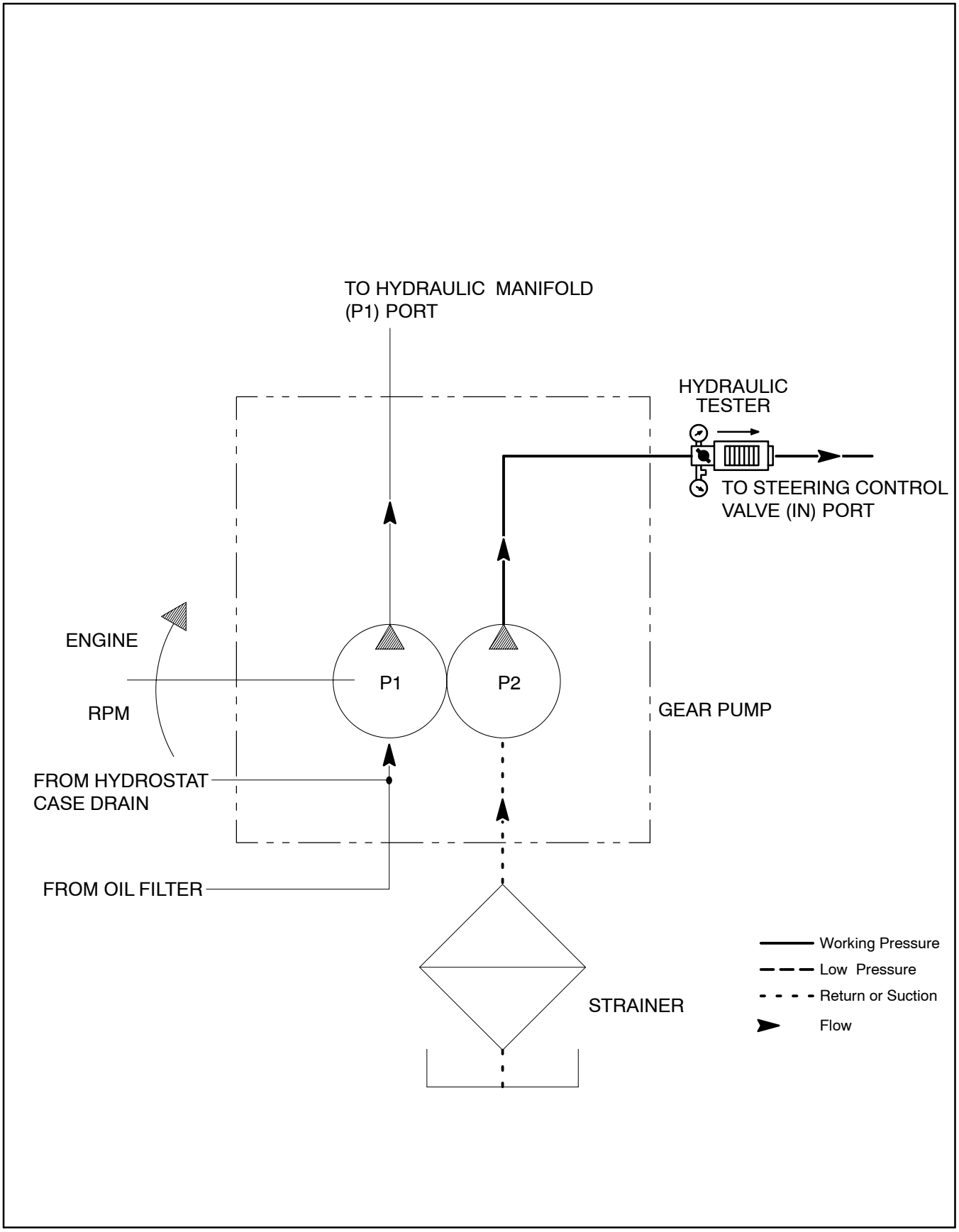


Figure 30

1. Gear pump (P2) **2. To steering control valve**

Gear Pump (P2) Flow Test (Using Tester with Pressure Gauges and Flow Meter)



Procedure for Gear Pump (P2) Flow Test:

1. Make sure hydraulic oil is at normal operating temperature.

2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

3. Read Precautions for Hydraulic Testing.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

4. Disconnect hose connection on the gear pump (P2) leading to the steering control valve (Fig. 31).

5. Install hydraulic tester (pressure and flow) in series with gear pump and the disconnected hose leading to the steering control valve.

6. Make sure the flow control valve on the tester is fully open.

7. Start engine and move throttle to full speed (3050 ± 50 RPM). **Do not engage the cutting units**.

IMPORTANT: In this test, the hydraulic tester is positioned before the manifold relief valve. Pump damage can occur if the oil flow is fully restricted by fully closing the tester flow control valve. Do not close tester valve fully when performing test.

8. Watch pressure gauge carefully while slowly closing the flow control valve until **800 PSI** is obtained. Verify with a phototac that the **pump speed** is **3100 RPM** while maintaining 800 PSI.

9. Flow indication should be **3.6 GPM** minimum.

10. Shut off engine. Record test results.

11. If flow was less than **3.6 GPM** or a pressure of **800 PSI** cannot be obtained, check for restriction in the pump intake line. If line is not restricted, remove gear pump (P2) and repair or replace as necessary.

NOTE: If necessary, Steering and Lift Relief Pressure Test can be conducted with tester as placed for this test.

12. Relieve hydraulic system pressure (See Relieving Hydraulic System Pressure in the General Information section). Disconnect tester from gear pump fitting and hose. Reconnect hose to the pump.

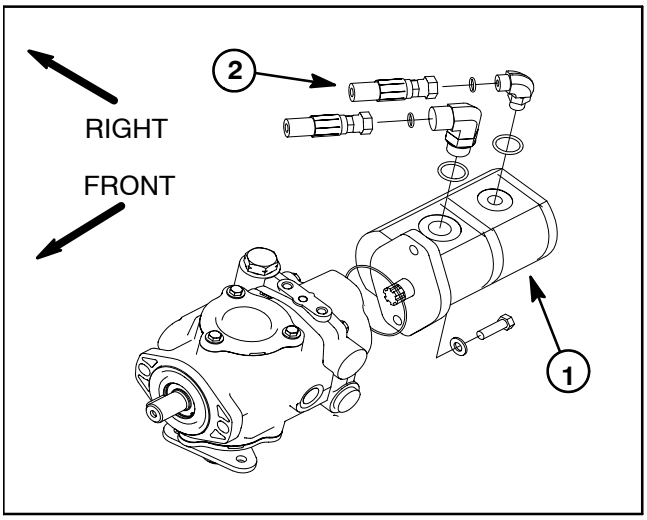
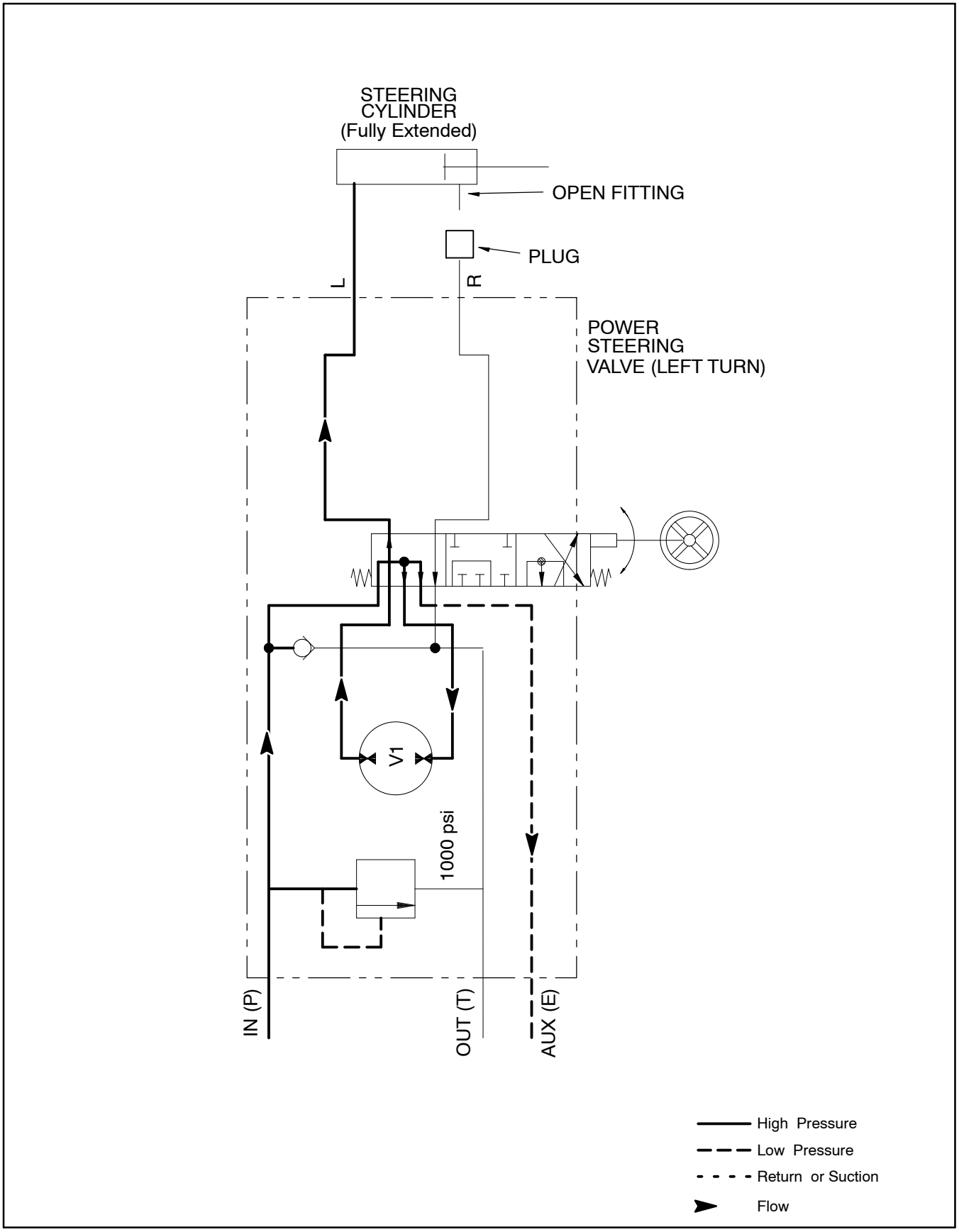


Figure 31

1. **Gear pump (P2)**
2. **To steering control valve**

Steering Control Valve Test



Procedure for Steering Control Valve Test:

1. Make sure hydraulic oil is at normal operating temperature.

2. Perform the Lift and Steering Control Valve Relief Pressure and Gear Pump (P2) Flow tests to make sure that pump and relief valve are functioning correctly.

NOTE: This steering test procedure will be affected by incorrect rear tire pressure, binding in the hydraulic steering cylinder, extra weight on the vehicle and/or binding of the steering fork assembly. Make sure that these items are checked before proceeding with any hydraulic testing procedure.

3. Drive machine slowly in a figure eight on a flat level surface.

   A. There should be no shaking or vibration in the steering wheel or rear wheel.

   B. Steering wheel movements should be followed **immediately** by a corresponding rear wheel movement **without** the steering wheel continuing to turn.

4. Stop unit with the engine running. Turn steering wheel with small quick movements in both directions. Let go of the steering wheel after each movement.

   A. The steering control valve should respond to each steering wheel movement.

   B. When steering wheel is released, steering control should return to the neutral position with no additional turning.

5. If either of these performance tests indicate a steering problem, determine if the steering cylinder is faulty using the following procedure.

   A. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

   B. Turn the steering wheel all the way to the left (counterclockwise) so the steering cylinder rod is fully extended.

   C. Read Precautions for Hydraulic Testing.

   D. Remove hydraulic hose from the 90º fitting on the rod end of the steering cylinder. Plug the end of the hose.

   E. With the engine off, continue turning the steering wheel to the left (counterclockwise) with the steering cylinder fully extended. Observe the open fitting on the steering cylinder as the wheel is turned. If oil comes out of the fitting while turning the steering wheel to the left, the steering cylinder has internal leakage and must be repaired or replaced.

   F. Remove plug from the hydraulic hose. Reconnect hose to the steering cylinder fitting.

6. If steering problem exists and steering cylinder tested acceptably, steering control requires service (see Steering Control Valve and Steering Control Valve Service in the Service and Repairs section).

Braking Valve Adjustment

The braking valve (BV) on the hydraulic manifold controls the stopping time for the cutting deck blades. The braking valve is adjustable. If adjustment of the braking valve is correct, the cutting deck blades should come to a complete stop within 7 seconds after the PTO switch is disengaged.

If blade stopping time is incorrect, adjustment of the braking valve (BV) can be performed as follows:

NOTE: Do not remove the braking valve from the hydraulic manifold for adjustment.

1. Loosen lock nut on braking valve (Fig. 32).

2. To **decrease** blade stopping time, turn the adjustment shaft on the valve in a counterclockwise direction.

3. To **increase** blade stopping time, turn the adjustment shaft on the valve in a clockwise direction.

4. Tighten lock nut to secure adjustment.

5. Check blade stopping time and readjust braking valve as needed.

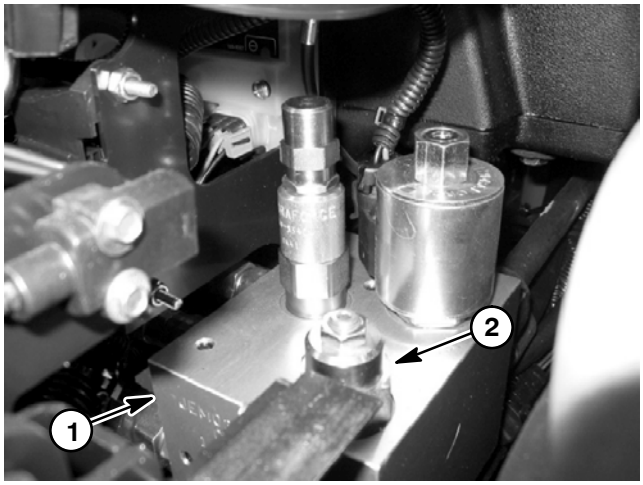


Figure 32

1. Manifold assembly **2. Braking valve (BV)**

General Precautions for Removing and Installing Hydraulic System Components

Before Repair or Replacement of Components

1. Before removing any parts from the hydraulic system, park machine on a level surface, engage parking brake, lower cutting units or attachments and stop engine. Remove key from the ignition switch.

2. Thoroughly clean machine before disconnecting, removing or disassembling any hydraulic components. Make sure hydraulic components, hoses, connections and fittings are cleaned thoroughly. Always keep in mind the need for cleanliness when working on hydraulic components.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

3. Put caps or plugs on any hydraulic lines, hydraulic fittings and components left open or exposed to prevent contamination.

4. Put labels on disconnected hydraulic lines and hoses for proper installation after repairs are completed.

5. Note the position of hydraulic fittings (especially elbow fittings) on hydraulic components before removal. Mark parts if necessary to make sure they will be aligned properly when reinstalling hydraulic fittings, hoses and tubes.

After Repair or Replacement of Components

1. Check oil level in the hydraulic reservoir and add correct oil if necessary. Drain and refill hydraulic system reservoir and change oil filter if component failure was severe or system is contaminated (see Flush Hydraulic System).

2. Lubricate o−rings and seals with clean hydraulic oil before installing hydraulic components.

3. Make sure caps or plugs are removed from the hydraulic tubes, hydraulic fittings and components before reconnecting.

4. Use proper tightening methods when installing hydraulic hoses and fittings (see Hydraulic Fitting Installation in the General Information section).

5. After repairs, check control linkages or cables for proper adjustment, binding or broken parts.

6. After disconnecting or replacing any hydraulic components, operate machine functions slowly until air is out of system (see Charge Hydraulic System).

7. Check for hydraulic oil leaks. Shut off engine and correct leaks if necessary. Check oil level in hydraulic reservoir and add correct oil if necessary.

Check Hydraulic Lines and Hoses

WARNING

Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Use paper or cardboard, not hands, to search for leaks. Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and cause serious injury. If fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury. Gangrene may result from such an injury.

Check hydraulic lines and hoses daily for leaks, kinked lines, loose mounting supports, wear, loose fittings, weather deterioration and chemical deterioration. Make any necessary repairs before operating equipment.

Flush Hydraulic System

IMPORTANT: Flush the hydraulic system any time there is a severe component failure or if the system is contaminated (oil appears milky, black or contains metal particles).

IMPORTANT: Flush hydraulic system when changIng from petroleum base hydraulic fluid to a biodegradable fluid such as Toro Biodegradable Hydraulic Fluid.

IMPORTANT: If a component failure occurred in the traction circuit, refer to Traction Circuit (Closed Loop) Component Failure in the General Information section for information regarding the importance of removing contamination from the traction circuit.

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for at least four (4) hours.

2. Park machine on a level surface. Lower cutting units, stop engine and engage parking brake. Remove key from the ignition switch.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

IMPORTANT: Make sure to thoroughly clean around all hydraulic connections that will be disassembled.

3. Drain hydraulic tank (see Traction Unit Operator's Manual).

4. Drain hydraulic system. Drain all hoses, tubes and components while the system is warm.

5. Change and replace hydraulic oil filter (see Traction Unit Operator's Manual).

6. Inspect and clean hydraulic oil tank (see Hydraulic Tank Inspection in this section).

7. Reconnect all hydraulic hoses, lines and components that were disconnected to drain hydraulic system.

NOTE: Use only hydraulic fluids specified in Traction Unit Operator's Manual. Other fluids may cause system damage.

8. Fill hydraulic tank with **new** hydraulic fluid (see Traction Unit Operator's Manual).

9. Disconnect wire harness lead from fuel stop solenoid to prevent the engine from starting. Make sure traction pedal and lift control lever are in the **neutral** position.

10. Turn ignition key switch and engage starter for ten (10) seconds to prime the traction and gear pumps. Wait fifteen (15) seconds to allow the starter motor to cool and then repeat cranking procedure again.

11. Connect wire harness electrical connector to fuel stop solenoid.

12. Start engine and let it idle at low speed (1400 $\pm$ 50 RPM) for a minimum of 2 minutes. Increase engine speed to high idle (3050 $\pm$ 50 RPM) for a minimum of 1 minute under no load.

13. Raise and lower cutting units several times. Turn steering wheel fully left and right several times.

14. Shut off engine and check for hydraulic oil leaks. Check oil level in hydraulic tank and add correct amount of oil if necessary (see Traction Unit Operator's Manual).

15. Operate the machine for 2 hours under normal operating conditions.

16. Check condition of hydraulic oil. If the new fluid shows any signs of contamination, repeat steps 1 through 14 again until oil is clean. If changing to biodegradable fluid, repeat steps 1 through 14 again at least once and until the oil is clean.

17. Assume normal operation and follow recommended maintenance intervals.

Charge Hydraulic System

NOTE: When initially starting the hydraulic system with new or rebuilt components such as motors, pumps or lift cylinders, it is important that the hydraulic system be charged properly. Air must be purged from the system and its components to reduce the chance of damage.

IMPORTANT: Change hydraulic oil filter whenever hydraulic components are repaired or replaced.

1. Park machine on a level surface and turn engine off.

2. Make sure all hydraulic connections, lines and components are secured tightly.

3. If component failure was severe or the system is contaminated, flush and refill hydraulic system and tank (see Flush Hydraulic System).

4. Make sure hydraulic tank is full. Add correct oil if necessary (see Traction Unit Operator's Manual).

5. Check control cable to the hydrostat for proper adjustment, binding or broken parts.

6. Disconnect fuel stop solenoid lead to prevent the engine from starting.

7. Make sure traction pedal and the lift control lever are in the **neutral** position. Turn ignition key switch and engage starter for ten (10) seconds to prime the traction and gear pumps. Wait fifteen (15) seconds to allow the starter motor to cool and then repeat cranking procedure again.

8. Reconnect fuel stop solenoid lead.

WARNING

Before jacking up the machine, review and follow Jacking Instructions in Chapter 1 – Safety.

9. Raise one front wheel off the floor and place support blocks under the frame. Chock remaining front wheel to prevent movement of the machine.

CAUTION

One front wheel will be off the ground. Make sure machine is supported so it will not move and accidentally fall to prevent injuring anyone under machine.

10. Make sure traction pedal and lift control lever are in **neutral**. Start engine and run at low idle speed (1400 ± 50 RPM). The charge pump should pick up oil and fill the hydraulic system. If there is no indication of fill in 30 seconds, stop the engine and determine the cause.

11. After the hydraulic system starts to show signs of fill, actuate lift control lever until the lift cylinders moves in and out several times. If the cylinders do not move after 10 to 15 seconds or the pump emits abnormal sounds, shut the engine off immediately and determine cause or problem. Inspect for the following:

    A. Loose filter or suction lines.

    B. Incorrect hose routing.

    C. Blocked suction line.

    D. Faulty charge relief valve.

    E. Loose or faulty coupler on the pump.

    F. Faulty charge pump (gear pump P2).

12. If lift cylinders move in 10 to 15 seconds, proceed to step 13.

13. Operate the traction pedal in the forward and reverse directions. The wheel off the floor should rotate in the proper direction.

    A. If the wheel rotates in the wrong direction, stop engine, remove lines from rear of hydrostat pump and reverse the connections.

    B. If the wheel rotates in the proper direction, stop engine.

14. Adjust traction pedal to the neutral position (see Traction Unit Operator's Manual).

15. Check operation of the traction interlock switch (see Check Interlock System in Chapter 5 – Electrical System).

16. Lower machine to ground. Remove chock from front wheel.

17. If the traction pump or a wheel motor was replaced or rebuilt, run the traction unit so all wheels turn slowly for 10 minutes.

18. Operate traction unit by gradually increasing its work load to full over a 10 minute period.

19. Stop the machine. Check hydraulic oil level and adjust if necessary. Check hydraulic components for leaks. Tighten any loose connections.

Hydraulic Tank

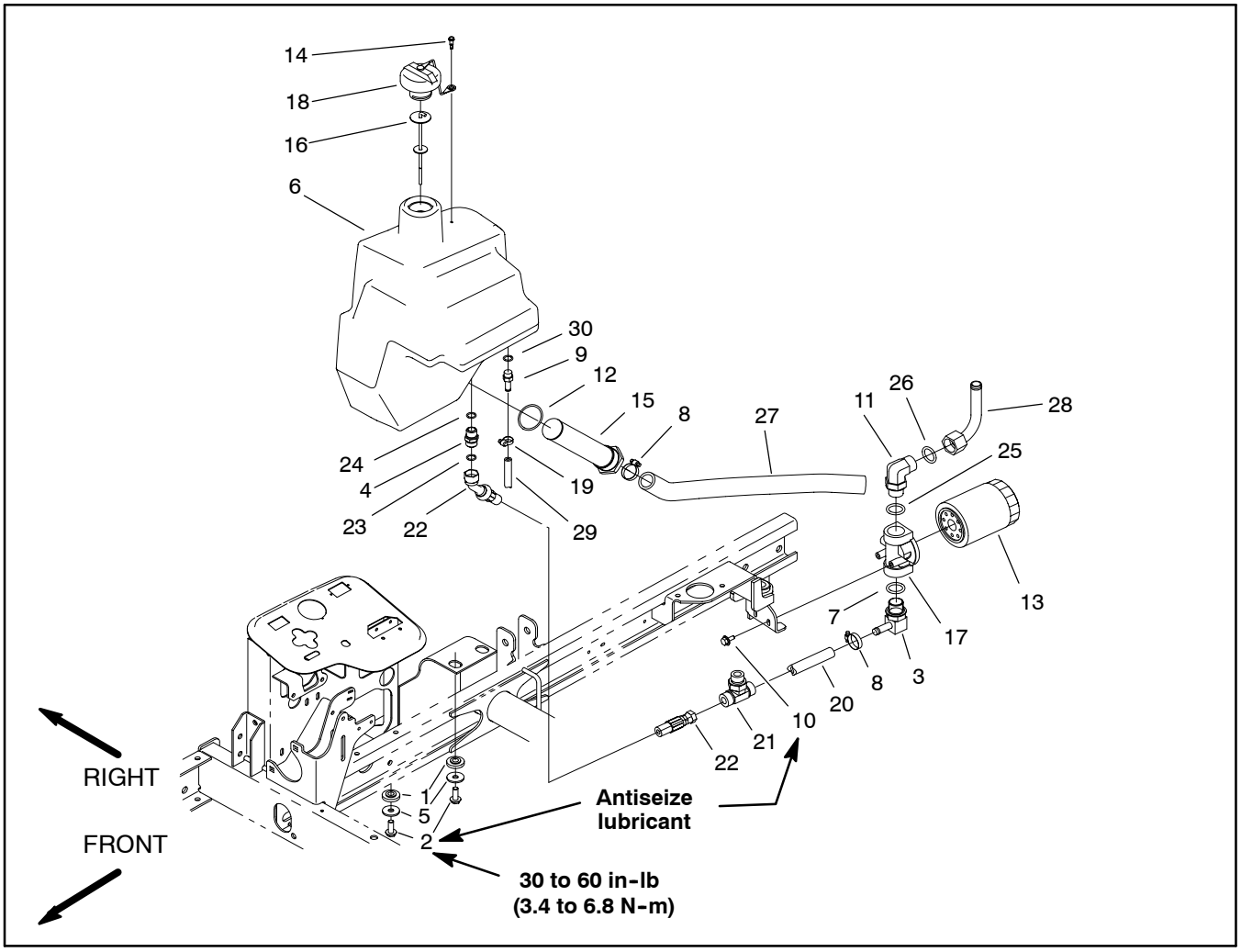


Figure 33

1. Grommet (4 used)
2. Flange head screw (4 used)
3. Barb fitting
4. Check fitting
5. Flat washer (4 used)
6. Hydraulic tank
7. O-ring
8. Hose clamp
9. Barb fitting (straight)
10. Flange head screw (2 used)
11. Elbow fitting
12. O-ring
13. Oil filter element
14. Shoulder screw
15. Suction strainer
16. Dipstick
17. Filter head
18. Hydraulic tank cap
19. Hose clamp
20. Hydraulic hose
21. Tee fitting
22. Hydraulic hose
23. O-ring
24. O-ring
25. O-ring
26. O-ring
27. Hydraulic hose (suction)
28. Hydraulic tube (from oil cooler)
29. Hydraulic hose (from manifold)
30. O-ring

Hydraulic Tank Removal (Fig. 33)

1. Drain hydraulic oil from Hydraulic tank (see Traction Unit Operator's Manual).

2. Thoroughly clean hydraulic hose ends and fittings on hydraulic tank to prevent hydraulic system contamination.

3. Remove hydraulic tank using Figure 33 as a guide. Discard and replace any o–rings that are removed.

Hydraulic Tank Inspection (Fig. 33)

1. Clean hydraulic tank and suction strainer with solvent.

2. Inspect hydraulic tank for leaks, cracks or other damage.

Hydraulic Tank Installation (Fig. 33)

1. Apply antiseize lubricant to the four (4) flange head screws that secure the hydraulic tank to the frame.

2. Position hydraulic tank to machine. Secure tank to frame with four (4) flange head screws, flat washers and grommets. Torque screws from 30 to 60 in–lb (3.4 to 6.8 N–m).

3. Attach fittings with new o–rings and hoses to hydraulic tank using Figure 33 as a guide.

4. Thread suction strainer into hydraulic tank.

5. Using a wrench, turn strainer into tank port 1–1/2 to 2 full turns beyond finger tight.

6. Fill hydraulic tank with **new** hydraulic fluid (see Traction Unit Operator's Manual).

7. Operate machine. Check hydraulic oil level and adjust if necessary. Check hydraulic components for leaks. Tighten any loose connections.

Oil Cooler

Removal

1. Thoroughly clean hydraulic hose ends and fittings on oil cooler to prevent hydraulic system contamination.

CAUTION

The radiator and oil cooler may be hot. To avoid possible burns, allow the engine and cooling systems to cool before working on the oil cooler.

2. Remove oil cooler using Figures 34 and 35 as guides.

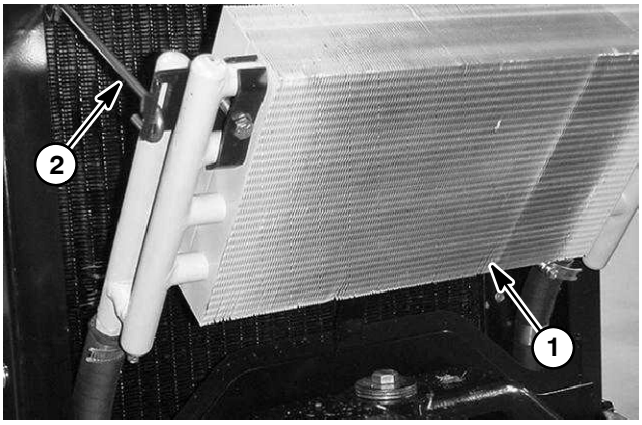


Figure 34

1. **Oil cooler**
2. **Latch**

Inspection

CAUTION

Use eye protection such as goggles when using compressed air.

1. Back flush oil cooler with cleaning solvent. After cooler is clean, make sure all solvent is drained from the cooler.

2. Dry inside of oil cooler using compressed air in the opposite direction of the oil flow.

3. Plug both ends of oil cooler. Clean exterior of cooler. Make sure oil cooler fins are clear of dirt and debris.

4. The oil cooler should be free of corrosion, cracked tubes or excessive pitting of tubes.

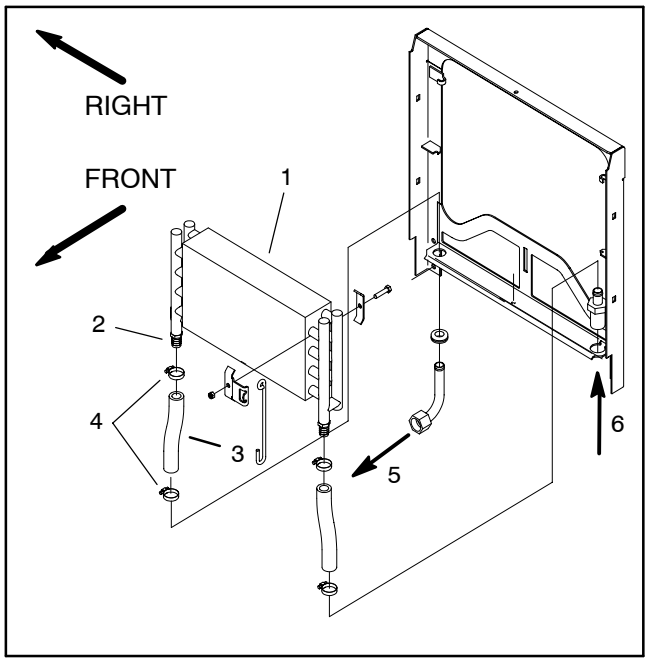


Figure 35

1. **Oil cooler**
2. **Barb fitting (2 used)**
3. **Hydraulic hose (2 used)**
4. **Hose clamp (4 used)**
5. **Flow to oil filter**
6. **Flow from manifold**

Installation

1. Install oil cooler using Figures 34 and 35 as guides.

2. Make sure hydraulic tank is full. Add correct oil if necessary (see Traction Unit Operator's Manual).

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Wheel Motors

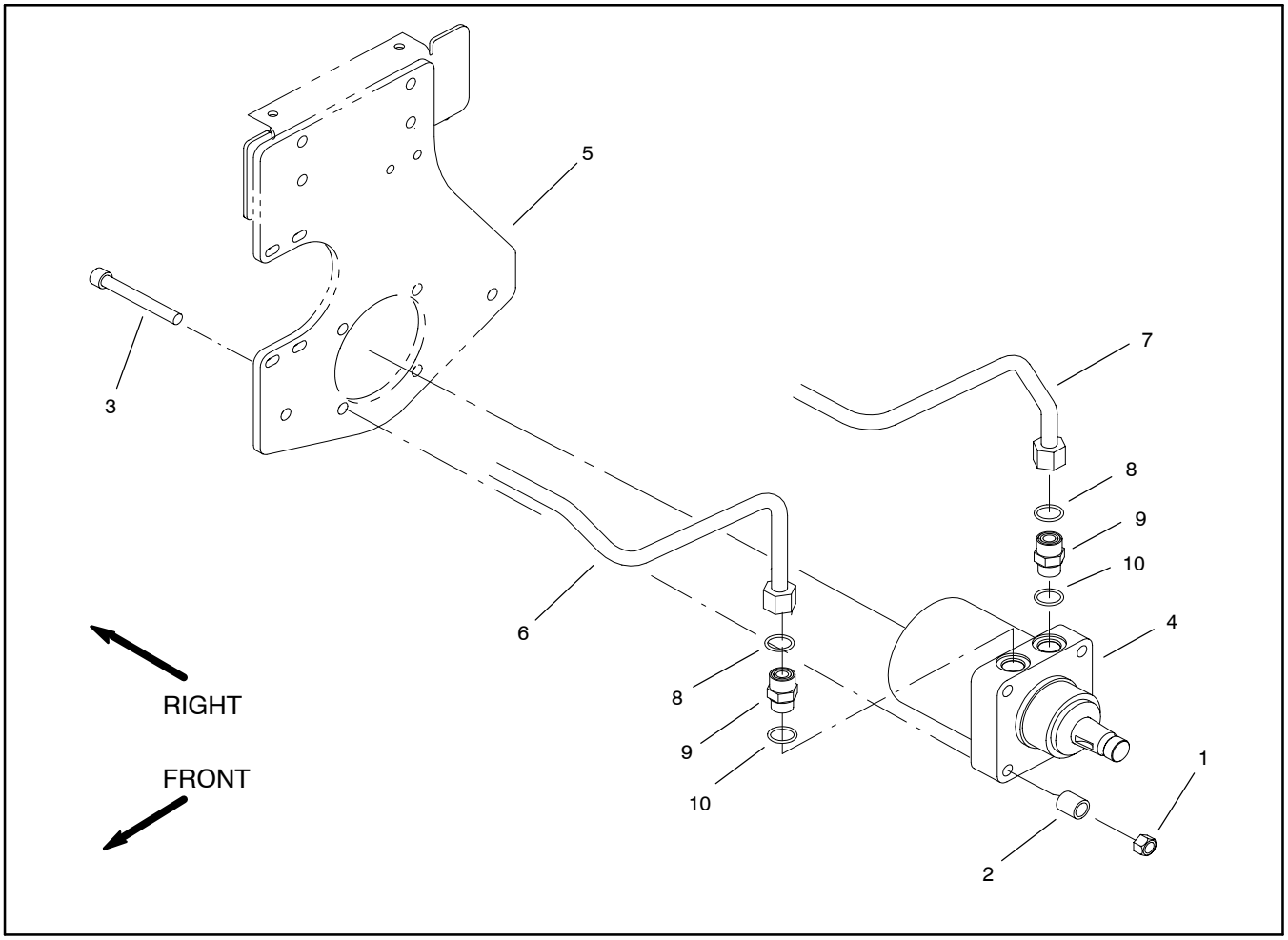

Figure 36

1. **Lock nut (4 per motor)**
2. **Spacer (4 per motor)**
3. **Socket head screw (4 per motor)**
4. **Hydraulic wheel motor (LH shown)**
5. **Frame**
6. **Hydraulic tube**
7. **Hydraulic tube**
8. **O-ring**
9. **Hydraulic fitting**
10. **O-ring**

Removal (Fig. 36)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

WARNING

Before jacking up the machine, review and follow Jacking Instructions in Chapter 1 – Safety.

2. Jack up front of machine enough to allow the removal of the front wheel. Support machine with jack stands or blocking.

IMPORTANT: DO NOT hit wheel hub, wheel hub puller or wheel motor with a hammer during removal or installation. Hammering may cause damage to the wheel motor.

3. Remove tire and wheel assembly, wheel hub and brake drum from the hydraulic motor. Remove brake assembly, brake bracket and wheel shield from the frame (see Front Wheel and Brake Removal in the Service and Repairs section of Chapter 6 – Chassis).

4. Thoroughly clean hydraulic hose ends and fittings on wheel motor to prevent hydraulic system contamination.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

5. Remove wheel motor from frame using Figure 36 as guide.

Installation (Fig. 36)

1. Install wheel motor to frame using Figure 36 as guide.

2. Install wheel shield, brake bracket and brake assembly to the frame. Install brake drum, wheel hub and wheel assembly to the hydraulic motor (see Front Wheel and Brake Installation in the Service and Repairs section of Chapter 6 – Chassis).

3. Lower the machine to the ground.

4. Make sure hydraulic tank is full. Add correct oil if necessary (see Traction Unit Operator's Manual).

Wheel Motor Service

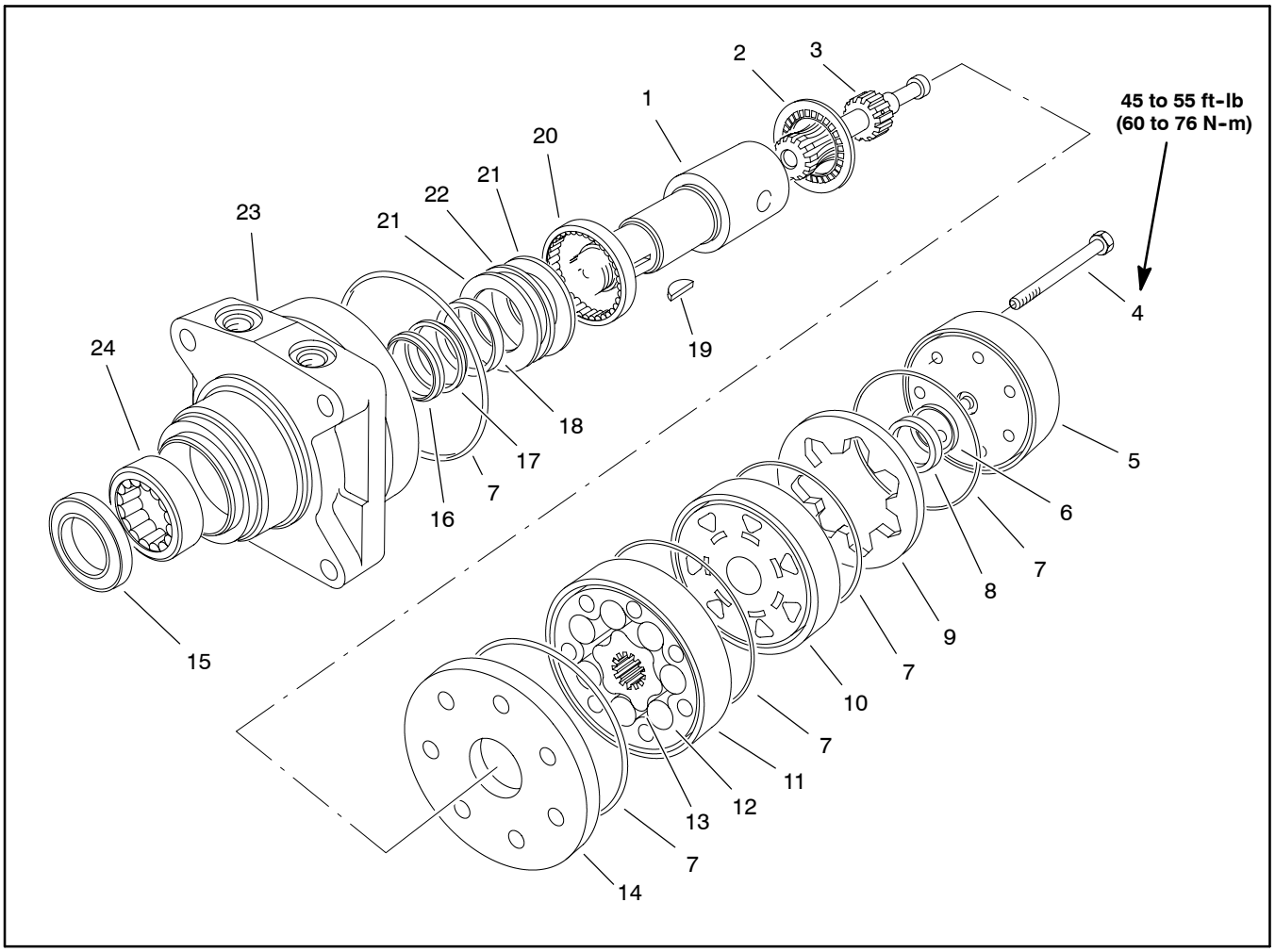

Figure 37

1. **Coupling shaft**
2. **Thrust bearing**
3. **Drive link**
4. **Cap screw (7 used)**
5. **End cover**
6. **Commutator seal**
7. **Seal ring**
8. **Commutator**
9. **Commutator ring**
10. **Manifold**
11. **Stator**
12. **Vane (7 used)**
13. **Rotor**
14. **Wear plate**
15. **Dirt and water seal**
16. **Back-up washer**
17. **Back-up washer**
18. **Inner seal**
19. **Woodruff key**
20. **Bearing**
21. **Thrust washer**
22. **Thrust bearing**
23. **Housing**
24. **Bearing**

NOTE: The two wheel motors used on the Groundsmaster 3505–D have the same basic construction. The right wheel motor has a reverse timed manifold.

IMPORTANT: If a wheel motor failure occurred, refer to Traction Circuit (Closed Loop) Component Failure in the General Information section for information regarding the importance of removing contamination from the traction circuit.

NOTE: For repair of the wheel motors, see the Ross Torqmotor ™ MG, MF, MP, MB, ME and MJ Series Service Procedure at the end of this chapter.

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Cutting Deck Motors

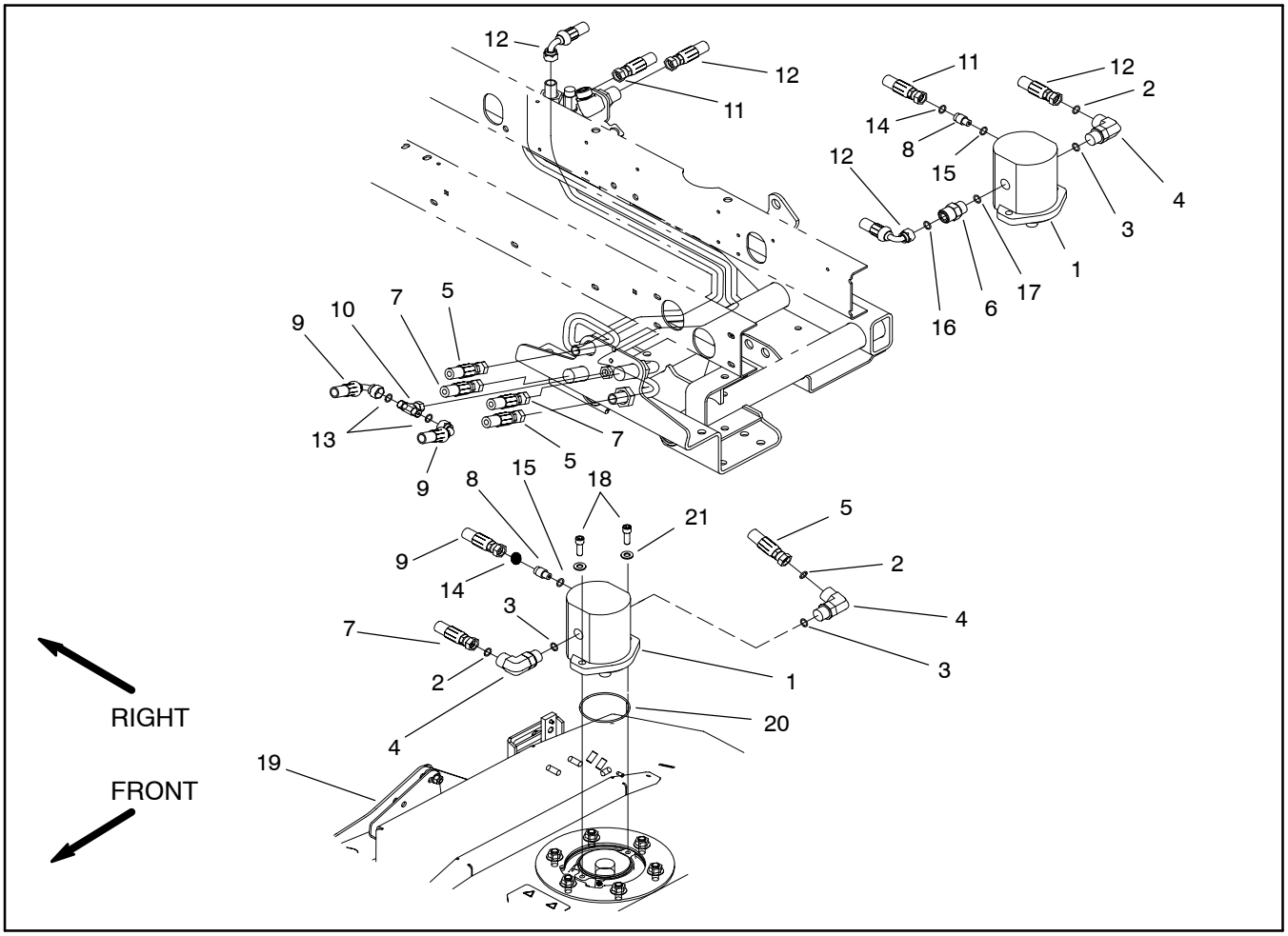

Figure 38

1. **Hydraulic motor**
2. **O-ring**
3. **O-ring**
4. **Hydraulic elbow**
5. **Hydraulic hose**
6. **Hydraulic adapter**
7. **Hydraulic hose**
8. **Hydraulic fitting**
9. **Hydraulic hose**
10. **Hydraulic T-fitting**
11. **Hydraulic hose**
12. **Hydraulic hose**
13. **O-ring**
14. **O-ring**
15. **O-ring**
16. **O-ring**
17. **O-ring**
18. **Socket head screw**
19. **Cutting deck**
20. **O-ring**
21. **Flat washer (2 used per motor)**

Removal (Fig. 38)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. Thoroughly clean hydraulic hose ends and fittings on deck motor to prevent hydraulic system contamination.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

NOTE: Note position of hydraulic hoses when removing hoses from the cutting deck motors. Proper positioning is critical when reconnecting hydraulic hoses. The inlet to the motor is opposite from the relief valve (Fig. 39).

3. Remove hydraulic hoses from motor using Figure 38 as a guide.

4. Remove two (2) socket head screws and flat washers that secure hydraulic motor to the cutting unit (Fig. 39). Remove hydraulic motor from deck. Locate and retrieve o−ring from top of spindle housing.

5. If hydraulic fittings are to be removed from motor, mark fitting orientation to allow correct assembly.

Installation (Fig. 38)

1. If fittings were removed, install fittings to motor using marks made during the removal process to properly orientate fittings.

2. Position o−ring to top of spindle housing. Install hydraulic motor to the cutting unit with two (2) socket head screws and flat washers.

3. Install hydraulic hoses to motor using Figure 38 as a guide.

4. Make sure hydraulic tank is full. Add correct oil if necessary (see Traction Unit Operator's Manual).

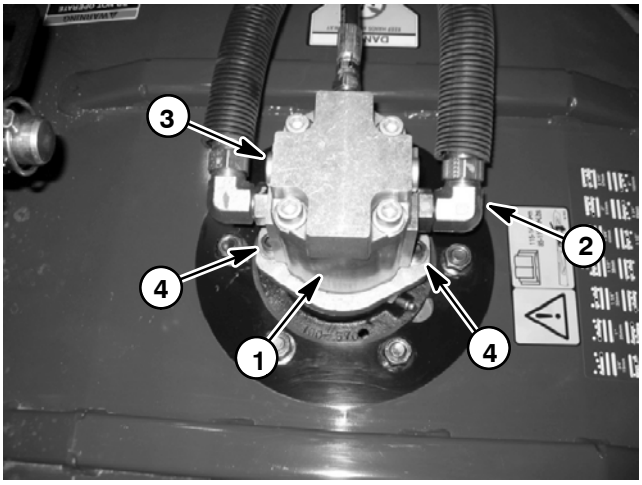

Figure 39

1. **Cutting deck motor**
2. **Inlet hose**
3. **Relief valve**
4. **Socket head screw**

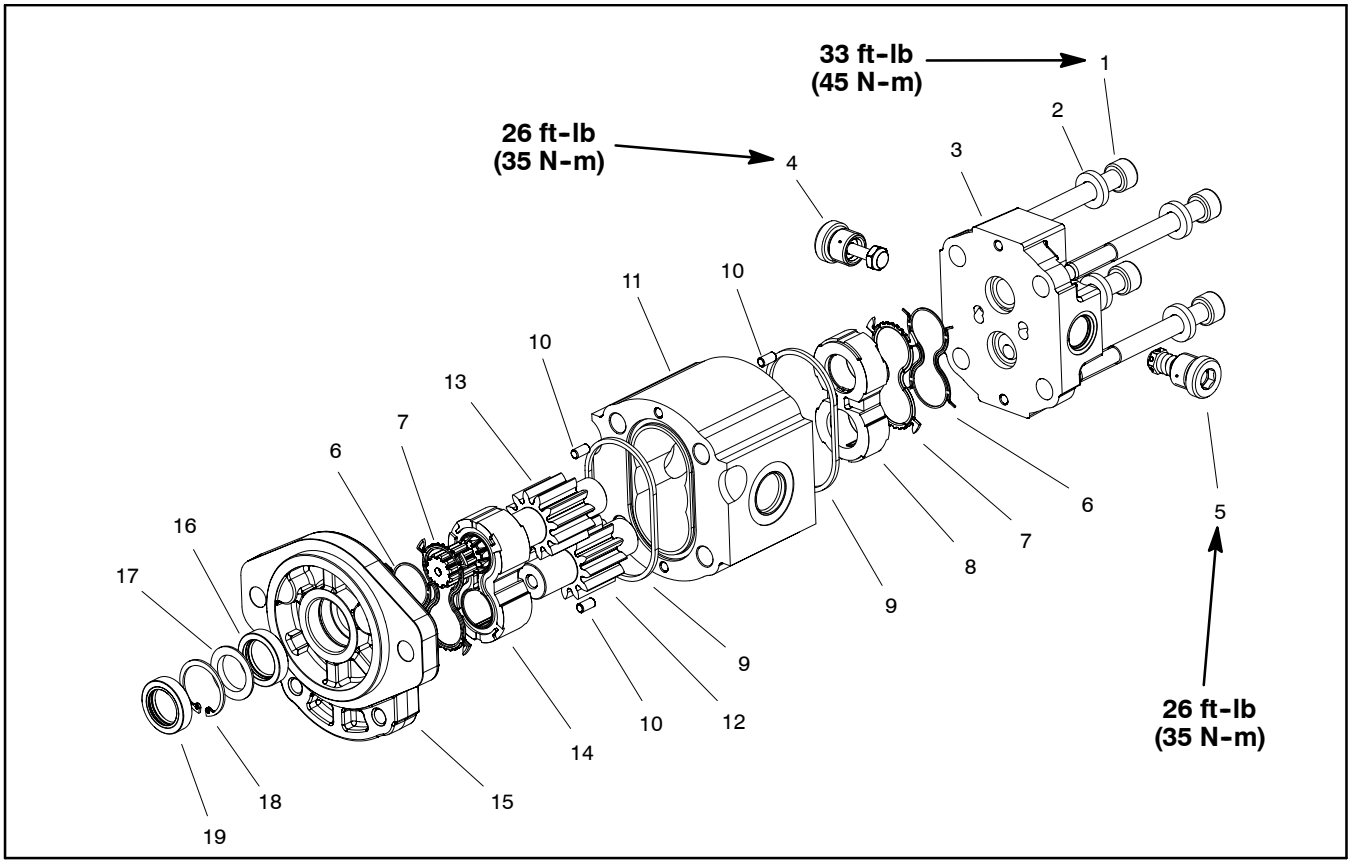

Figure 40

1. Socket head screw (4 used)
2. Washer (4 used)
3. Back plate
4. Anti-cavitation valve
5. Relief valve
6. Pressure seal
7. Back up gasket
8. Rear wear plate
9. O-ring
10. Dowel pin (4 used)
11. Body
12. Idler gear
13. Drive gear
14. Front wear plate
15. Front plate
16. Shaft seal
17. Washer
18. Retaining ring
19. Seal

Disassembly (Fig. 40)

1. Plug motor ports and clean the outside of the motor thoroughly. After cleaning, remove plugs and drain any oil out of the motor.

2. Use a marker to make a **diagonal** line across the front plate, body and back plate for assembly purposes (Fig. 41).

IMPORTANT: Avoid using excessive clamping pressure on the motor housing to prevent distorting the housing.

3. Clamp mounting flange of motor in a vise with the shaft end down.

4. Loosen socket head screws from the back plate.

5. Remove motor from the vise. Turn motor so that the shaft end is facing down. Remove socket head screws.

6. Remove back plate from the body.

7. Carefully remove body. Lift body straight up to remove. Make sure the rear wear plate remains on the drive and idler gear shafts. Remove and discard o-rings from the body. Locate and retrieve dowel pins.

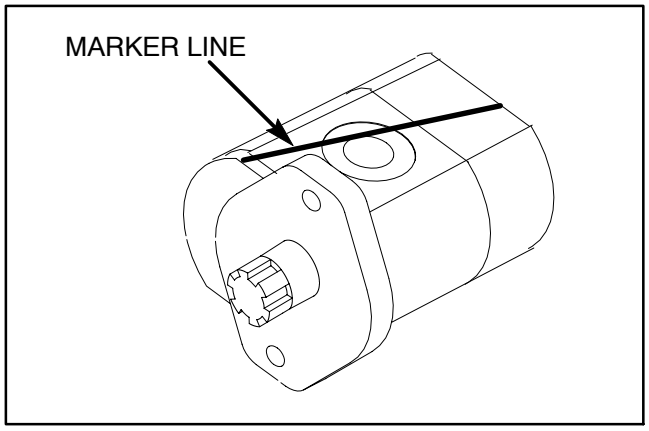

Figure 41

IMPORTANT: Note position of the open and closed side of the wear plates before removing. Also, identify wear plates (front and rear) for proper reassembly. Do not scribe wear plates.

8. Carefully remove rear wear plate, idler gear, drive gear and front wear plate from the front plate.

9. Remove and discard back-up gaskets and pressure seals from wear plates.

IMPORTANT: Make sure not to damage the front plate counter bore when removing the components from the front plate.

10. Turn front plate over, with seal side up and carefully remove the seal, retaining ring, washer and shaft seal. Discard seals.

11. If necessary, remove anti-cavitation and relief valves from back plate.

Inspection

1. Remove any nicks and burrs from all parts with emery cloth.

CAUTION

Use eye protection such as goggles when using compressed air.

2. Clean all parts with solvent. Dry all parts with compressed air.

3. Inspect drive gears and idler gears for the following (Fig. 42):

A. Drive gear shaft spline should be free of twisted or broken teeth.

B. Gear shafts should be free of rough surfaces and excessive wear at bushing points and sealing areas. Scoring, rough surfaces or wear on gear shafts indicates need for replacement.

C. Gear teeth should be free of excessive scoring and wear. Any broken or nicked gear teeth must be replaced.

D. Inspect gear face edge for sharpness. Sharp edges of gears will mill into wear plates and, thus, must be replaced.

4. Inspect wear plates for the following:

A. Bearing areas should not have excessive wear or scoring.

B. Face of wear plates that are in contact with gears should be free of wear, roughness or scoring.

C. Thickness of wear plates should be equal.

5. Inspect front plate and back plate for damage or wear.

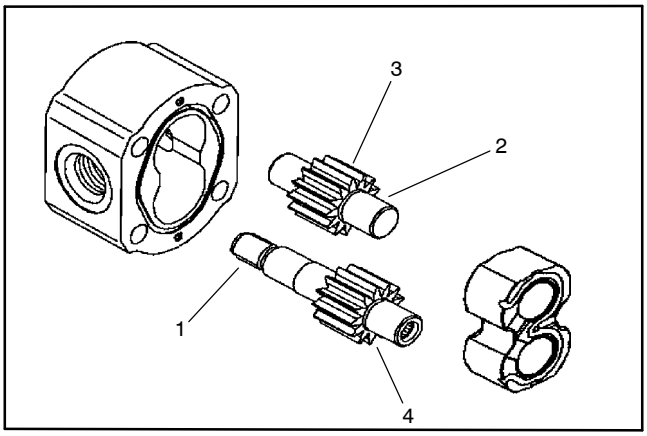

Figure 42

1. **Gear shaft spline**
2. **Gear shaft**
3. **Gear teeth**
4. **Gear face edge**

Assembly (Fig. 40)

NOTE: When assembling the motor, check the marker line on each part to make sure the components are properly aligned during assembly (Fig. 41).

1. Lubricate new o-rings, pressure seals, back-up gaskets and wear plate grooves with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic oil.

2. Install new shaft seal in front plate. Seal should be pressed into place until it reaches the bottom of the bore.

3. Install washer and then retaining ring into the groove of the front plate. Press seal into front plate.

4. Place front plate, seal side down, on a flat surface.

5. Install the backup gaskets into the grooves in the wear plates. Follow by carefully placing the pressure seals to the backup gaskets and wear plate.

6. Apply a light coating of petroleum jelly to the exposed side of the front plate.

7. Lubricate the drive gear shaft with clean hydraulic oil. Insert the drive end of the drive shaft through the front wear plate with the pressure seal side down and the open side of the pressure seal pointing to the inlet side of the motor. Carefully install drive shaft into front plate.

8. Lubricate the idler gear shaft with clean hydraulic oil. Install idler gear shaft into the remaining position in the front wear plate. Apply a light coating of clean hydraulic oil to drive and idler gear faces.

9. Install rear wear plate with pressure seal side up and open side of the pressure seal pointing to the inlet side of the motor.

10. Apply a light coating of petroleum jelly to new o-rings and o-ring grooves in the body. Install new o-rings to the body.

11. Install locating dowels in body. Align marker line on the body and front plate (Fig. 41).

IMPORTANT: Do not dislodge seals during installation.

12. Gently slide the body onto the assembly using marker line for proper location. Firm hand pressure should be sufficient to engage the dowel pins.

13. Check to make sure that the surface of the rear wear plate is slightly below the face of the body. If the wear plate is not below the body, check assembly for a shifted pressure seal, backup gasket or o-ring. Correct before proceeding.

14. Apply a light coating of petroleum jelly to the exposed side of the back plate.

15. Place back plate on assembly. Firm hand pressure should be sufficient to engage the dowels.

16. Install the four (4) socket head screws with washers and hand tighten.

IMPORTANT: Avoid using excessive clamping pressure on the motor housing to prevent distorting the housing.

17. Place mounting flange of the motor into a vise and alternately torque the socket head screws 33 ft-lb (45 N-m).

18. Remove motor from vise.

19. Place a small amount of clean hydraulic oil in the inlet of the motor and rotate the drive shaft away from the inlet one revolution. If any binding is noted, disassemble the pump and check for assembly problems.

20. If removed, install anti-cavitation and relief valves into back plate. Torque valves 26 ft-lb (35 N-m).

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Hydraulic Manifold

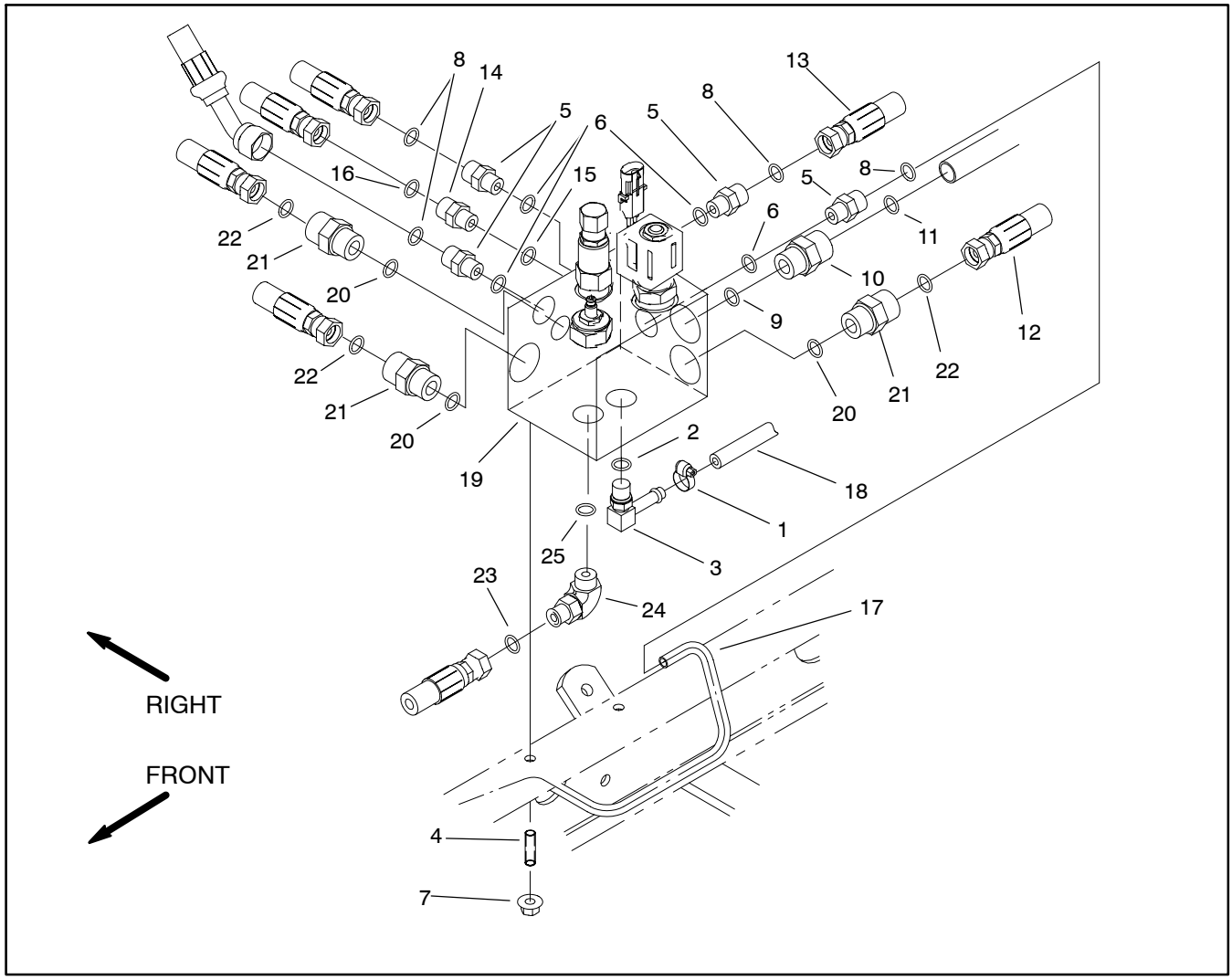

Figure 43

1. Hose clamp
2. O-ring
3. Barb fitting
4. Stud (2 used)
5. Straight hydraulic fitting
6. O-ring
7. Flange head nut (2 used)
8. O-ring
9. O-ring
10. Straight hydraulic fitting
11. O-ring
12. Hydraulic hose
13. Hydraulic hose
14. Straight hydraulic fitting
15. O-ring
16. O-ring
17. Hydraulic tube
18. Hydraulic hose
19. Hydraulic manifold
20. O-ring
21. Straight hydraulic fitting
22. O-ring
23. O-ring
24. 90º hydraulic fitting
25. O-ring

Removal (Fig. 43)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

NOTE: The ports on the manifold are marked for easy identification of components. Example: BV is the deck circuit braking valve and P1 is the gear pump connection port (see Hydraulic Schematic to identify the function of the hydraulic lines and cartridge valves at each port location).

2. Thoroughly clean hydraulic manifold before doing any disassembly.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

3. Label all hydraulic hoses and fittings for assembly purposes. Also, mark fittings to allow correct assembly orientation.

4. Remove hydraulic manifold from the machine using Figure 43 as guide.

Installation (Fig. 43)

1. Install hydraulic manifold to the frame using Figure 43 as guide. Use labels and marks made during the removal process to properly install hoses and fittings.

2. Make sure hydraulic tank is full. Add correct oil if necessary (see Traction Unit Operator's Manual).

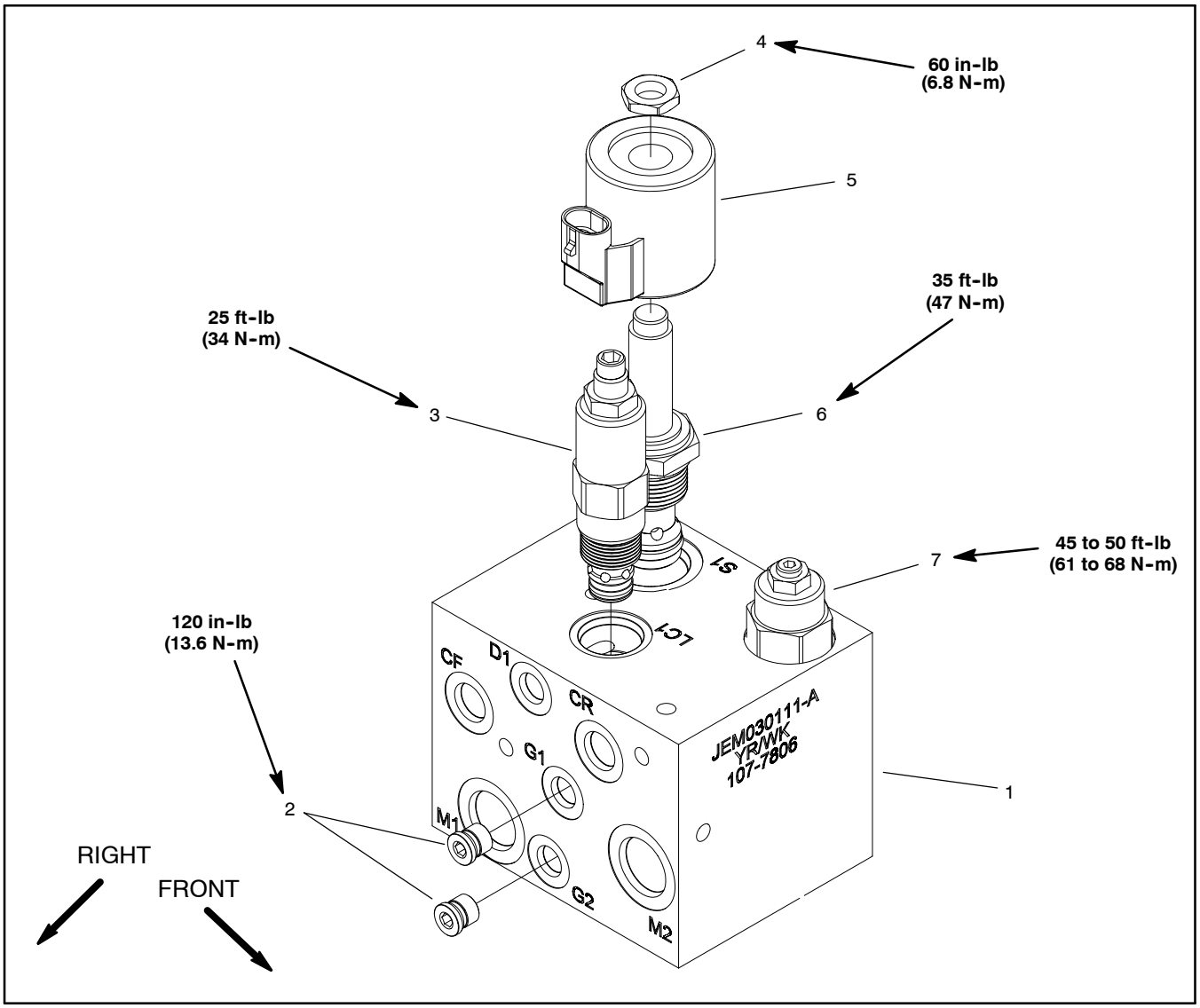

Figure 44

1. **Manifold body**
2. **NWD #4 plug**
3. **Logic cartridge valve (LC1)**
4. **Nut**
5. **Solenoid coil**
6. **Solenoid cartridge valve (R1)**
7. **Braking cartridge valve (BV)**

NOTE: The ports on the manifold are marked for easy identification of components. Examples: BV is the deck circuit braking valve and P1 is the gear pump connection port (see Hydraulic Schematic to identify the function of the hydraulic lines and cartridge valves at each port location).

NOTE: The Groundsmaster 3505-D hydraulic manifold uses several zero leak plugs. These plugs have a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero leak plugs also have an o-ring as a secondary seal. If zero leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug.

Cartridge Valve Service (Fig. 44)

1. Make sure the manifold is clean before removing the valve.

2. If cartridge is solenoid operated, remove nut securing solenoid to the cartridge valve. Carefully slide solenoid coil off the valve.

IMPORTANT: Use care when handling the cartridge valve. Slight bending or distortion of the stem tube can cause binding and malfunction.

3. Remove cartridge valve with a deep socket wrench. Note correct location for o−rings, sealing rings and backup rings. Remove and discard seal kit.

4. Visually inspect the port in the manifold for damage to the sealing surfaces, damaged threads or contamination.

5. Visually inspect cartridge valve for damaged sealing surfaces and contamination.

A. Contamination may cause valves to stick or hang up. Contamination can become lodged in small valve orifices or seal areas causing malfunction.

B. If valve sealing surfaces appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.

CAUTION

Use eye protection such as goggles when using compressed air.

6. Clean cartridge valve using clean mineral spirits. Submerge valve in clean mineral spirits to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. Be extremely careful not to damage cartridge. Use compressed air for cleaning.

7. Reinstall the cartridge valve into the manifold block:

A. Lubricate new seal kit components with clean hydraulic oil and install on valve. The o−rings, sealing rings and backup rings must be arranged properly on the cartridge valve for proper operation and sealing.

IMPORTANT: Use care when handling the valve cartridge. Slight bending or distortion of the stem tube can cause binding and malfunction.

B. Thread cartridge valve carefully into manifold port. The valve should go in easily without binding.

C. Torque cartridge valve using a deep socket to value identified in manifold illustration (Fig. 44).

D. If cartridge is solenoid operated, carefully install solenoid coil to the cartridge valve. Torque nut to value identified in manifold illustration (Fig. 44).

8. If problems still exist, remove valve and clean again or replace valve.

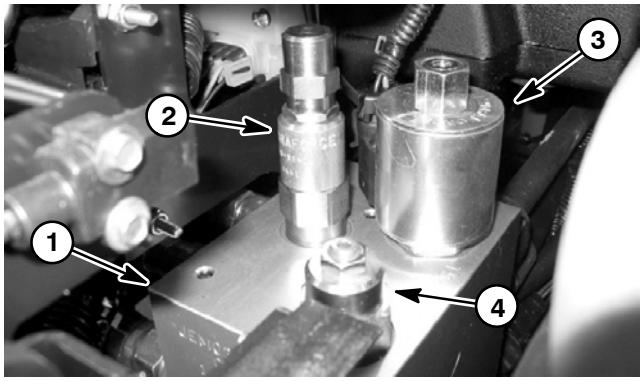

Figure 45

1. **Manifold assembly**
2. **Logic valve (LC1)**
3. **Solenoid valve (R1)**
4. **Braking valve (BV)**

Lift Control Valve

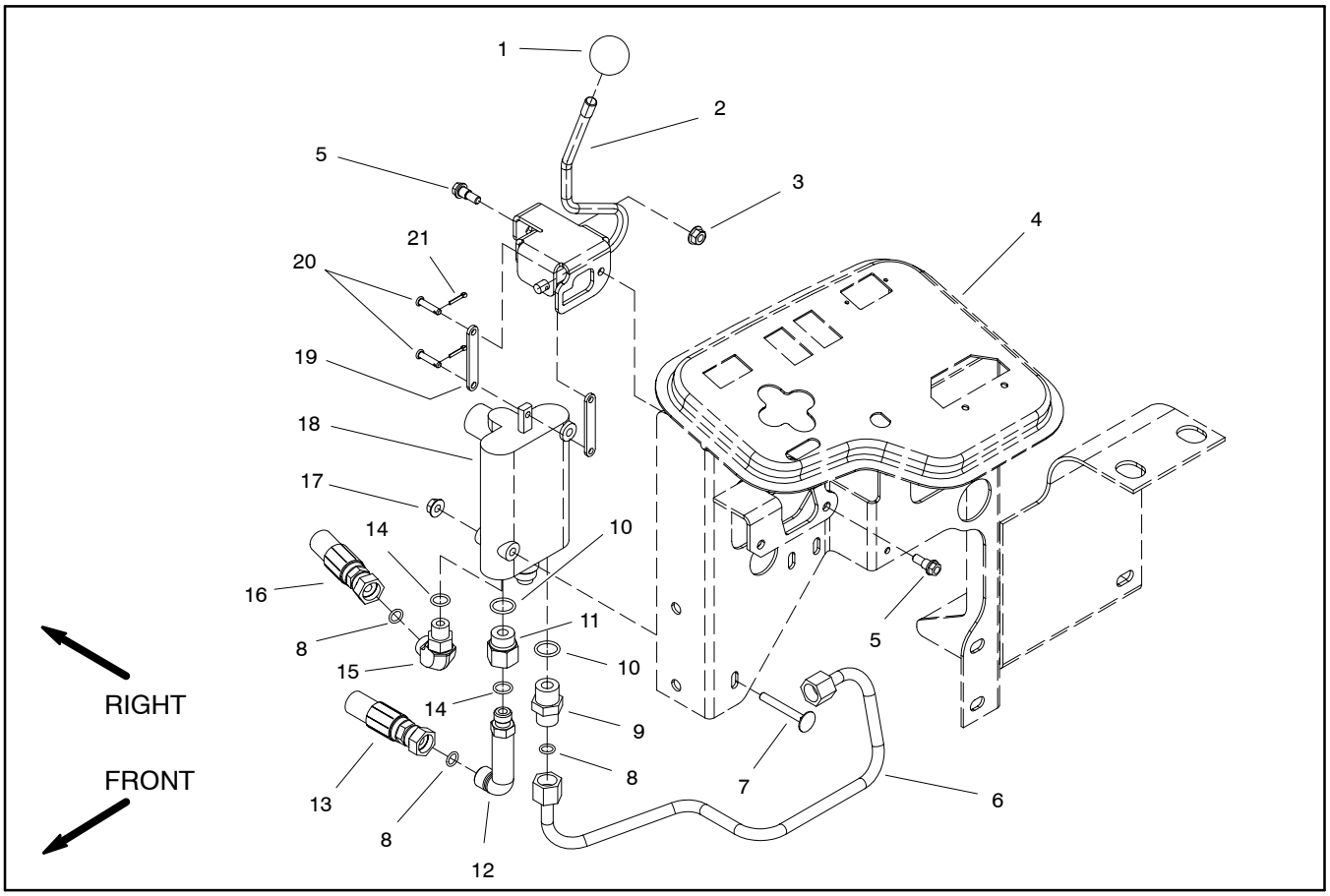

Figure 46

1. **Knob**
2. **Lever assembly**
3. **Flange nut (2 used)**
4. **Control panel**
5. **Shoulder bolt (2 used)**
6. **Hydraulic tube**
7. **Carriage screw (2 used)**
8. **O-ring**
9. **Hydraulic adapter**
10. **O-ring**
11. **Hydraulic adapter**
12. **Hydraulic 90º fitting**
13. **Hydraulic hose**
14. **O-ring**
15. **Hydraulic 90º fitting**
16. **Hydraulic hose**
17. **Flange nut (2 used)**
18. **Lift control valve**
19. **Link (2 used)**
20. **Clevis pin (2 used)**
21. **Cotter pin (2 used)**

Removal (Fig. 46)

1. Thoroughly clean hydraulic hose ends and fittings on lift cylinder to prevent hydraulic system contamination.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

2. Remove control valve from the frame using Figures 46 and 47 as guides.

3. If hydraulic fittings are to be removed from control valve, mark fitting orientation to allow correct assembly.

Installation (Fig. 46)

1. If fittings were removed, install fittings to control valve using marks made during the removal process to properly orientate fittings.

2. Install control valve to the frame using Figures 46 and 47 as guides.

3. Make sure hydraulic tank is full. Add correct oil if necessary (see Traction Unit Operator's Manual).

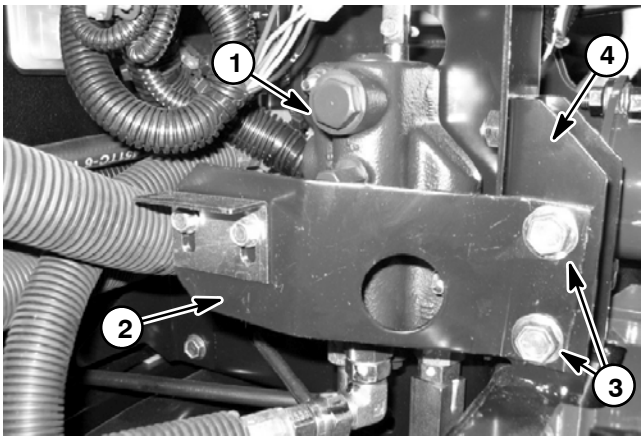

Figure 47

1. **Lift control valve**
2. **Support bracket**
3. **Flange head screws**
4. **Frame**

Lift Control Valve Service

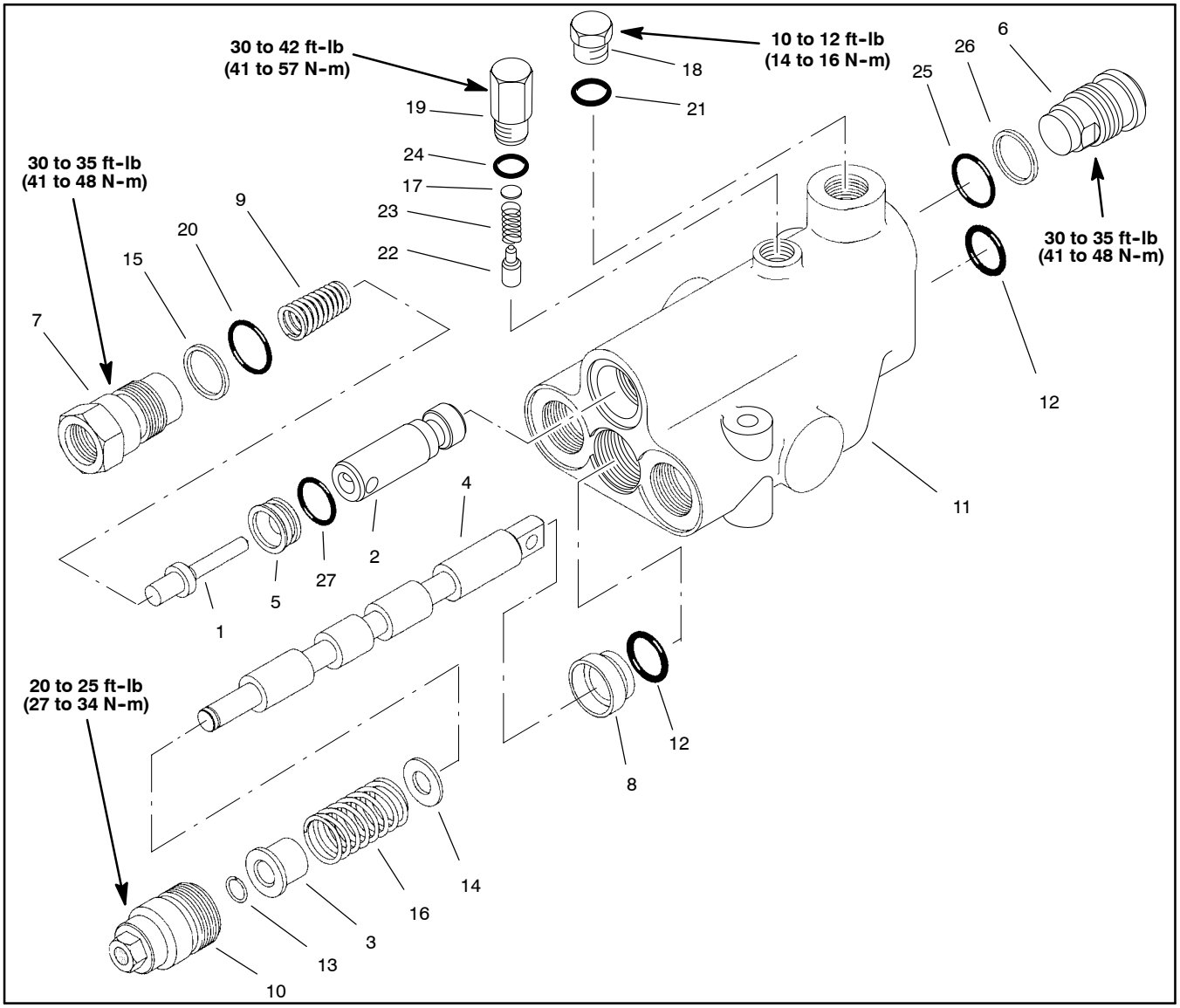

Figure 48

1. Check poppet
2. Plunger
3. Spacer
4. Spool
5. Seat
6. Plug (solid)
7. Seat retaining plug
8. Bushing
9. Check spring
10. Spool cap
11. Valve body
12. O-ring
13. Retaining ring
14. Washer
15. Back-up washer
16. Spool spring
17. Disc
18. Plug
19. Detent plug
20. O-ring
21. O-ring
22. Detent plunger
23. Spring
24. O-ring
25. O-ring
26. Back-up washer
27. O-ring

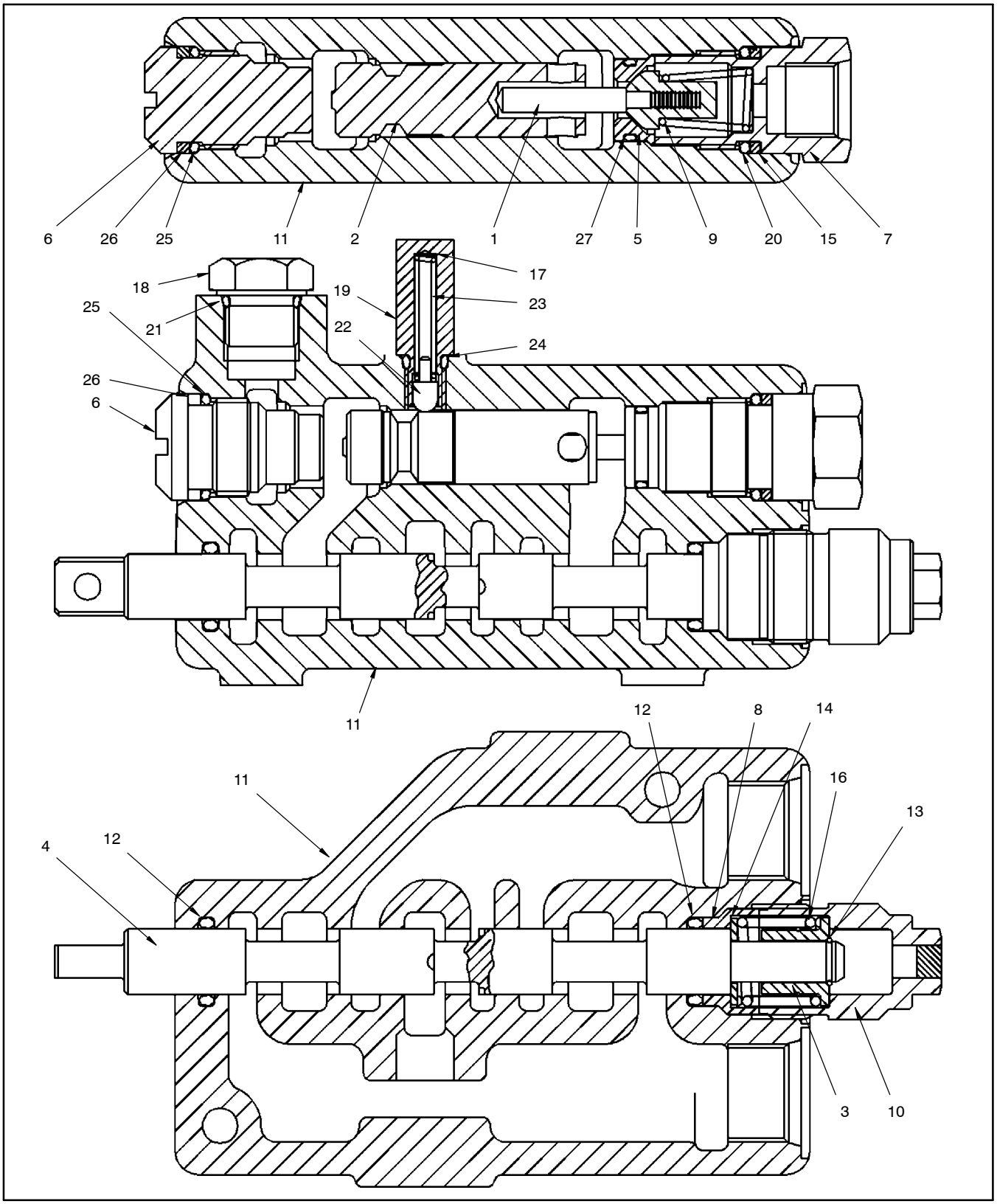

Figure 49

1. Check poppet
2. Plunger
3. Spacer
4. Spool
5. Seat
6. Plug (solid)
7. Seat retaining plug
8. Bushing
9. Check spring
10. Spool cap
11. Valve body
12. O-ring
13. Retaining ring
14. Washer
15. Back-up washer
16. Spool spring
17. Disc
18. Plug
19. Detent plug
20. O-ring
21. O-ring
22. Detent plunger
23. Spring
24. O-ring
25. O-ring
26. Back-up washer
27. O-ring

Disassembly (Figs. 48 and 49)

1. Plug all ports and clean the outside of the valve thoroughly.

2. Remove spool cap (item 10) and slide the spool assembly from its bore.

3. Remove o−ring (item 12) and bushing (item 8) from the spool assembly.

4. Remove o−ring from the spool bore end that is opposite the spool cap.

NOTE: Disassemble spool assembly only if the retaining ring, spacer, spring or washer need replacing.

5. Remove seat retaining plug (item 7), back−up washer (item 15), o−ring (item 20) and check spring (item 9) from the valve body.

6. Remove check poppet (item 1), seat (item 5), o−ring (item 27) and plunger (item 2) from the valve body.

7. Remove solid plug (item 6), back−up washer (item 26) and o−ring (item 25) from the opposite end of the plunger.

8. Remove plug (item 18) and o−ring (item 21) from the top of the valve body next to the detent plug.

9. Remove detent plug (item 19) and o−ring (item 24) from the valve body. Remove disc (item 17), spring (item 23) and detent plunger (item 22) from the body.

Inspection

1. Inspect spool and spool bore for wear. If wear is excessive, replace lift control valve.

2. Inspect springs and replace as necessary.

3. Inspect plunger, detent plunger and check poppet for wear. Replace as necessary.

4. Inspect seat, spacer and bushing for wear. Replace as necessary.

5. Inspect disc and washer. Replace as necessary.

6. Inspect cap and plugs for damaged threads and O−ring sealing surfaces. Replace as necessary.

Assembly (Figs. 48 and 49)

IMPORTANT: Do not wipe parts dry with paper towels or rags. Lint free cloth must be used to prevent lint from causing damage to the hydraulic system.

CAUTION

Use eye protection such as goggles when using compressed air.

1. Clean all metal parts with solvent and blow dry with compressed air.

2. Replace check poppet (item 1), all o−rings and all back−up washers with new ones.

3. Install new o−rings into the valve body.

4. Slide bushing (item 8) and new o−ring (item 12) over the spool.

5. If the spool was disassembled, install washer (item 14), spool spring (item 16), spacer (item 3) and retaining ring (item 13) to the spool.

6. Lubricate spool assembly liberally with clean hydraulic fluid and install into its proper bore.

7. Install spool cap (item 10) into valve body. Torque cap from 20 to 25 ft−lb (27 to 34 N−m).

8. Install o−ring (item 25), back−up washer (item 26) and solid plug (item 6) into the bore on the opposite end of the plunger. Torque plug from 30 to 35 ft−lb (41 to 48 N−m).

9. Lubricate plunger (item 2) liberally with clean hydraulic fluid and install into its valve body bore.

10. Install new o−ring (item 27), seat (item 5), check poppet (item 1) and check spring (item 9) into the plunger bore.

11. Install new o−ring (item 20), back−up washer (item 15) and seat retaining plug (item 7) into the plunger bore. Torque plug from 30 to 35 ft−lb (41 to 48 N−m).

12. Install new o−ring (item 21) and plug (item 18) into the top of the valve body next to the detent plug bore. Torque plug from 10 to 12 ft−lb (14 to 16 N−m).

13. Lubricate plunger detent (item 22), spring (item 23) and disc (item 17) liberally with clean hydraulic fluid and install into its valve body bore.

14. Install new o−ring (item 24) and detent plug (item 19) into its proper bore. Torque plug from 30 to 42 ft−lb (41 to 57 N−m).

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Neutral Arm Assembly

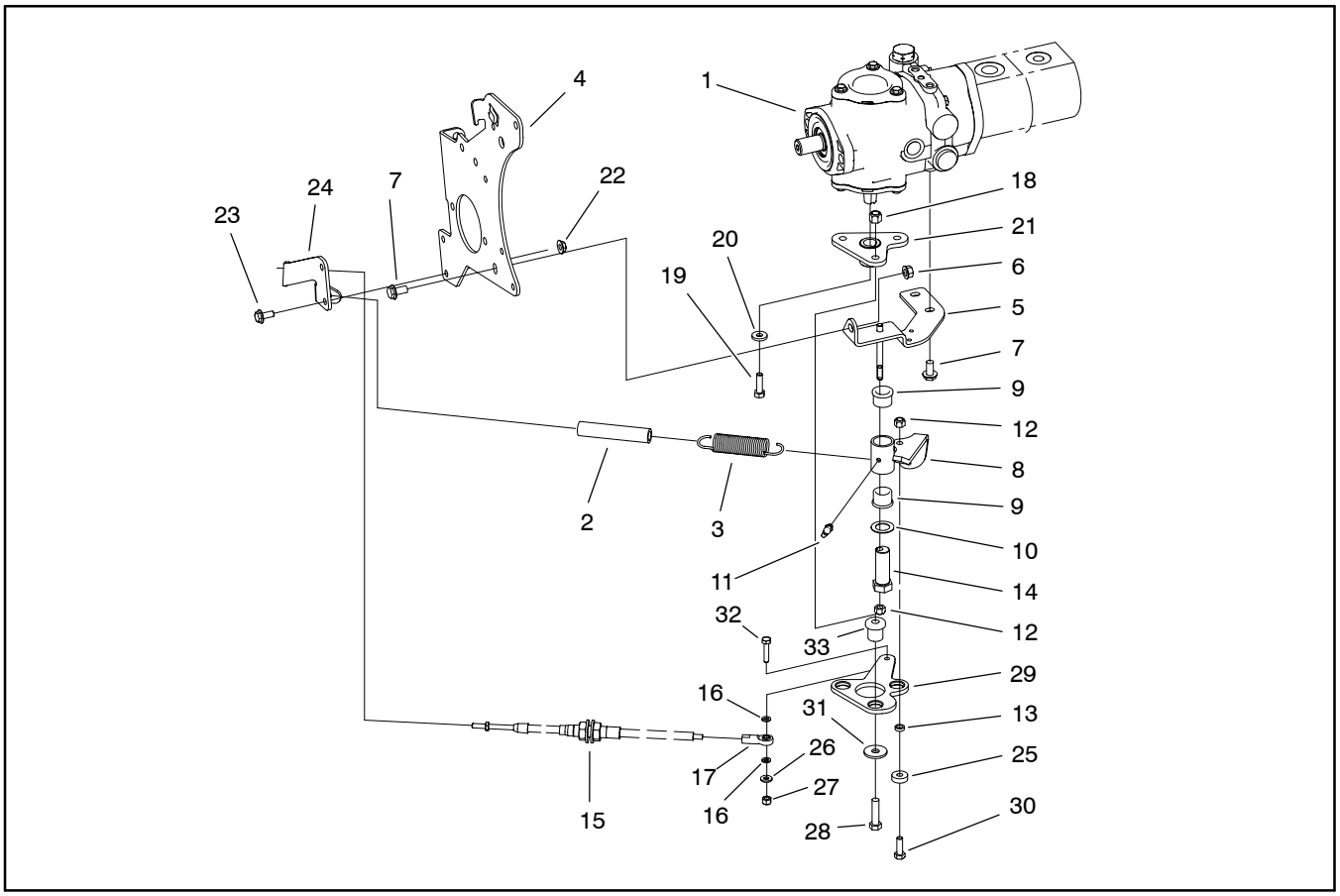

Figure 50

1. **Pump assembly**
2. **Hose**
3. **Extension spring**
4. **Pump mount plate**
5. **Neutral bracket**
6. **Flange nut**
7. **Flange head screw (3 used)**
8. **Neutral arm**
9. **Flange bushing**
10. **Thrust washer**
11. **90º grease fitting**
12. **Lock nut (2 used)**
13. **Spacer**
14. **Traction stud**
15. **Traction control cable**
16. **Flat washer**
17. **Ball joint**
18. **Lock nut (3 used)**
19. **Cap screw**
20. **Flat washer**
21. **Hub assembly**
22. **Flange nut (2 used)**
23. **Flange head screw (2 used)**
24. **Cable support bracket**
25. **Ball bearing**
26. **Flat washer**
27. **Lock nut**
28. **Socket head screw (3 used)**
29. **Pump lever**
30. **Cap screw**
31. **Flat washer (3 used)**
32. **Cap screw**
33. **Mount (3 used)**

Removal (Fig. 50)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

CAUTION

The extension spring is under tension and may cause personal injury during removal. Use caution when removing spring from the pump lever.

2. Remove extension spring (item 3) from the cable support bracket (item 24) and neutral arm (item 8).

3. Disconnect traction control cable (item 15) from the pump lever (item 29). Locate and retrieve three (3) flat washers (items 16 and 17) and note their position for assembly purposes.

4. Remove both flange head screws (item 7) securing the neutral bracket (item 5) to the piston pump. Remove flange nut (item 6) and flange head screw (item 7) securing the neutral bracket to the pump mount plate.

5. Remove cap screw (item 19) and flat washer (item 20) that secure the pump lever (item 29) and hub (item 21) assembly to the piston pump trunnion.

6. Separate pump lever (item 29) and hub (item 21) assembly from pump trunnion and neutral bracket (item 5) from mount plate. Locate and retrieve key from trunnion.

Installation (Fig. 50)

1. Install key into trunnion slot. Position neutral bracket (item 5) to the mount plate and the pump lever (item 29) and hub (item 21) assembly to the pump trunnion.

2. Secure pump lever (item 29) and hub (item 21) assembly to the piston pump trunnion with flat washer (item 20) and cap screw (item 19).

3. Secure neutral bracket (item 5) to the pump mount plate with flange head screw (item 7) and flange nut (item 6). Secure neutral bracket to the piston pump with both flange head screws (item 7).

4. Position three (3) flat washers (items 16 and 17) to traction control cable end. Secure traction control cable to the pump lever with cap screw (item 32) and lock nut (item 27).

CAUTION

The extension spring is under tension and may cause personal injury during installation. Use caution when installing the spring to the pump lever.

5. Install extension spring (item 3) to the cable support bracket and neutral arm.

6. Adjust traction drive for neutral (see Traction Unit Operator's Manual).

Piston Pump

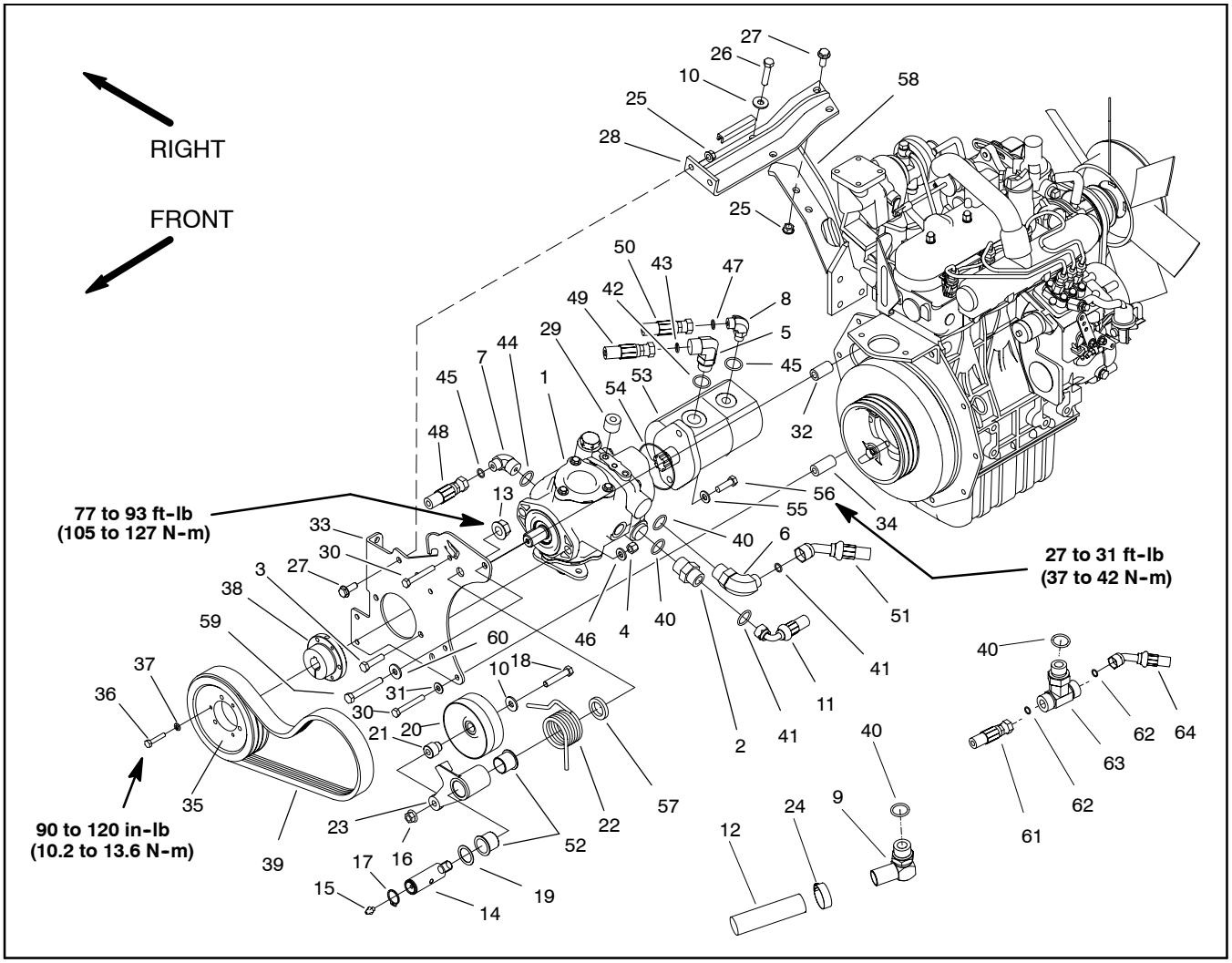

Figure 51

1. Piston pump
2. Straight hydraulic fitting
3. Cap screw (2 used)
4. Lock nut (2 used)
5. 90º hydraulic fitting
6. 90º hydraulic fitting
7. 90º hydraulic fitting
8. 90º hydraulic fitting
9. 90º hydraulic fitting
10. Washer (3 used)
11. Hydraulic hose
12. Suction hose
13. Flange nut
14. Idler pivot pin
15. Grease fitting
16. Flange nut
17. Retaining ring
18. Cap screw
19. Thrust washer
20. Idler pulley
21. Spacer
22. Torsion spring
23. Idler arm
24. Hose clamp
25. Flange nut (4 used)
26. Cap screw (2 used)
27. Flange head screw (4 used)
28. Pump support
29. Spacer (2 used)
30. Cap screw (4 used)
31. Flat washer (3 used)
32. Spacer
33. Pump mount plate
34. Pump mount spacer (4 used)
35. Pulley
36. Cap screw (3 used)
37. Lock washer (3 used)
38. Taper lock bushing
39. V-belt
40. O-ring
41. O-ring
42. O-ring
43. O-ring
44. O-ring
45. O-ring
46. Flat washer (2 used)
47. O-ring
48. Hydraulic hose
49. Hydraulic hose
50. Hydraulic hose
51. Hydraulic hose
52. Bushing
53. Gear pump
54. O-ring
55. Flat washer (2 used)
56. Cap screw (2 used)
57. Idler arm spacer
58. Engine mount
59. Cap screw
60. Flat washer
61. Hydraulic hose
62. O-ring
63. Tee fitting
64. Hydraulic hose

Piston Pump Removal (Fig. 51)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. Remove traction belt from the pulley (see Traction Unit Operator's Manual).

3. Remove neutral arm assembly from the piston pump (see Neutral Arm Assembly Removal in this section).

4. Drain hydraulic oil from Hydraulic tank (see Traction Unit Operator's Manual).

5. Thoroughly clean hydraulic hose ends and fittings on piston pump to prevent hydraulic system contamination.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

6. Label all hydraulic hoses and fittings for assembly purposes.

7. Disconnect all hydraulic hoses connected to the hydraulic fittings on the piston and gear pumps. Allow hoses to drain into a suitable container. Plug hose openings to prevent contamination.

CAUTION

Support piston and gear pumps when removing them from the pump support and pump mount plate to prevent them from falling and causing personal injury.

8. Remove both flange head screws (item 27) and flange nuts (item 25) that secure pump support (item 28) to engine mount (item 58).

9. Remove fasteners and spacers securing the pump mount plate to the engine (Fig. 52). Note location of cap screws, washers and spacers for assembly purposes. Pull pump mount plate with pumps, pump pulley, pump support and idler assembly from the machine.

10. Remove both cap screws (item 56) and flat washers (item 55) securing gear pump to the piston pump. Separate gear pump from the piston pump. Locate and retrieve o-ring (item 54). Plug openings of gear pump to prevent contamination.

11. If hydraulic fittings are to be removed from piston pump, mark fitting orientation to allow correct assembly. Remove hydraulic fittings and o-rings from the piston pump as needed.

12. Remove pulley from the taper lock bushing:

A. Remove three (3) cap screws (item 36) and lock washers (item 37) securing pulley to the taper lock bushing.

IMPORTANT: Excessive or unequal pressure on the cap screws can break the bushing flange.

B. Insert cap screws into threaded removal holes of the pulley. Tighten screws progressively and evenly until the pulley is loose on the bushing. Remove pulley from the bushing.

13. Loosen set screw that secures taper lock bushing to piston pump. Remove bushing from the pump shaft. Locate and retrieve key from pump shaft.

14. Remove both cap screws (item 26) and washers (item 10) that secure piston pump to pump support (item 28). Locate and retrieve spacers (item 29).

15. Remove lock nuts (item 4), flat washers (item 46) and cap screws (item 3) that secure the piston pump to the pump mount plate. Remove pump from plate.

Piston Pump Installation (Figs. 51)

1. Position and secure piston pump to the pump mount plate with flat washers (item 46), cap screws (item 3) and lock nuts (item 4).

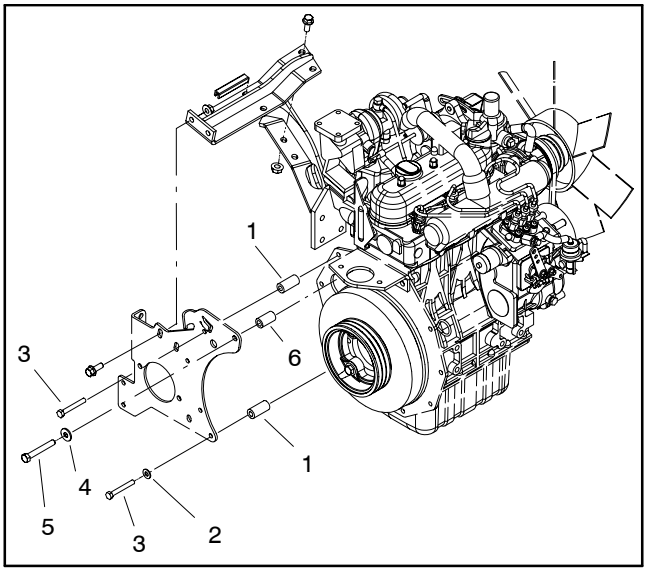

Figure 52

1. Long spacer (4 used)
2. Flat washer (3 used)
3. Cap screw (4 used)
4. Flat washer
5. Cap screw
6. Short spacer

2. Remove plugs from piston pump openings that were placed during disassembly. Install hydraulic fittings with new o−rings to their original positions on the piston pump.

NOTE: If installing a new gear pump to the piston pump, make sure to remove the plug from the suction port of the gear pump (Fig. 53). The gear pump suction fitting must be on the same side as the trunnion of the piston pump.

3. Remove plugs that were placed during disassembly from gear pump openings. Position o−ring (item 54) and gear pump to the piston pump and secure with flat washers (item 55) and cap screws (item 56). Torque cap screws from 27 to 31 ft−lb (37 to 42 N−m).

4. Place key into pump shaft slot. Slide taper lock bushing onto the piston pump shaft with bushing flange toward pump housing.

5. Make sure that tapered surfaces of pulley and taper lock bushing are thoroughly clean (no oil, grease, dirt, rust, etc.).

6. Position pulley to taper lock bushing and align non−threaded holes of pulley with threaded holes of bushing. Loosely install three (3) cap screws with lock washers to bushing and pulley.

CAUTION

Support piston and gear pumps when installing them to the machine to prevent them from falling and causing personal injury.

7. Position pump mount plate with pumps, pump pulley and idler assembly to the machine. Install fasteners and spacers securing the pump mount plate to the engine and pump support (Fig. 52). Tighten fasteners securely.

8. Position and secure pump support (item 28) to pump mount plate, piston pump and engine mount with removed fasteners and spacers.

9. Install traction belt (see Traction Unit Operator's Manual).

10. Using a straight edge across the lower face of the pump pulley, verify traction belt alignment across engine and pump pulleys. Slide pulley and taper lock bushing on pump shaft so that traction belt and straight edge are aligned indicating correct position of pump pulley. Secure taper lock bushing in position with set screw.

IMPORTANT: When tightening bushing cap screws, tighten in three equal steps and in a circular pattern.

11. Secure taper lock bushing by tightening three (3) cap screws to a torque from 90 to 120 in−lb (10.2 to 13.6 N−m) in three equal steps and in a circular pattern to secure pulley and taper lock bushing.

12. Check that belt alignment is still correct. If needed, loosen and re−adjust pulley and taper lock bushing location on pump shaft to allow for correct belt alignment.

13. Remove plugs that were placed during disassembly from hydraulic hoses. Connect all hydraulic hoses with new o−rings to piston and gear pumps.

14. Install neutral arm assembly to the piston pump (see Neutral Arm Assembly Installation in this section).

15. Fill hydraulic tank with **new** hydraulic fluid (see Traction Unit Operator's Manual).

16. Adjust traction drive for neutral (see Traction Unit Operator's Manual).

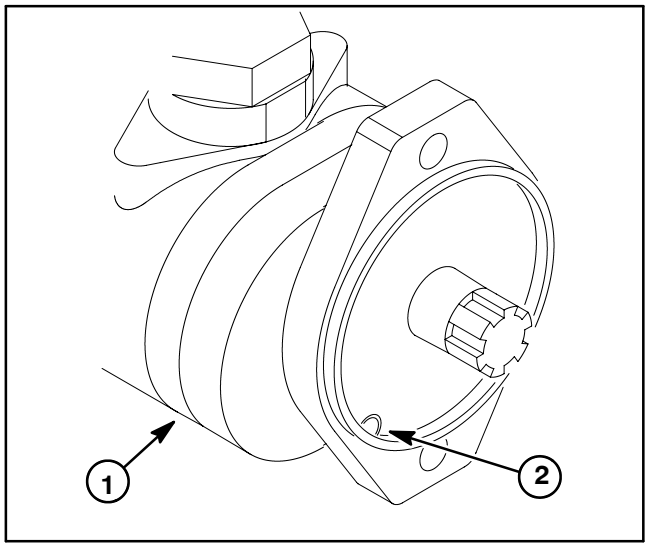

Figure 53

1. Gear pump
2. Suction port

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Piston Pump Service

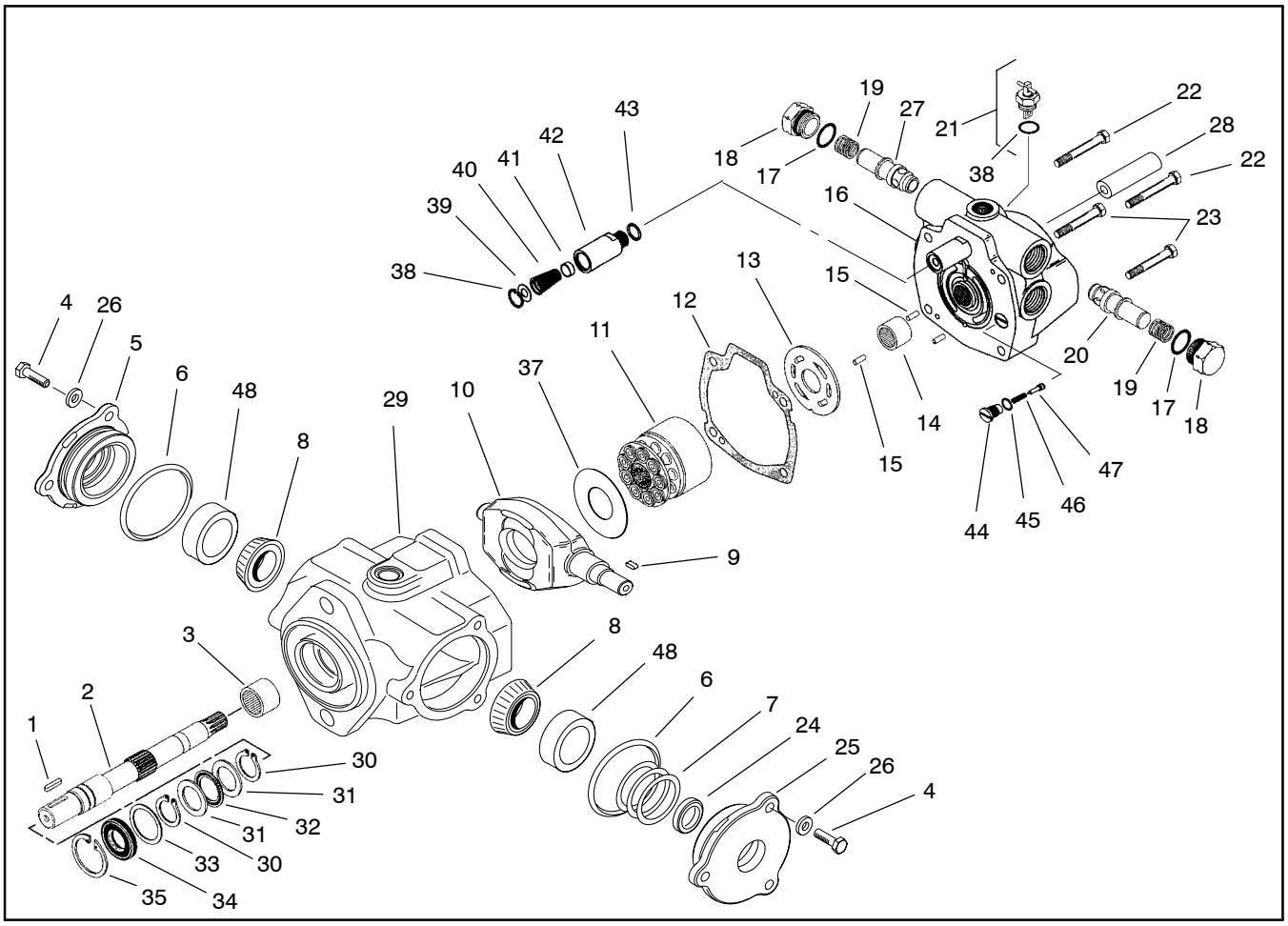

Figure 54

1. Key
2. Drive shaft
3. Bearing
4. Cap screw (3 used per plate)
5. Cover plate
6. O-ring
7. Shim
8. Bearing cone
9. Key
10. Cam plate
11. Rotating kit
12. Gasket
13. Cam plate
14. Bearing
15. Dowel pin
16. Back plate
17. O-ring
18. Plug
19. Spring
20. Seat
21. Bypass valve
22. Cap screw
23. Cap screw
24. Shaft seal
25. Cover plate
26. Washer (3 used per plate)
27. Relief valve
28. Coupler
29. Housing
30. Retaining ring
31. Thrust washer
32. Thrust bearing
33. Washer
34. Shaft seal
35. Retaining ring
36. Retaining ring
37. Cam plate insert
38. Retaining ring
39. Washer
40. Charge relief spring
41. Charge relief poppet
42. Charge relief housing
43. O-ring
44. Cartridge
45. O-ring
46. Bleed-off spring
47. Bleed-off valve poppet
48. Bearing cup

NOTE: For repair of the piston pump, see the Eaton Medium Duty Piston Pump Repair Information Model 70160 Variable Displacement Piston Pump at the end of this chapter.

IMPORTANT: If a piston pump failure occurred, refer to Traction Circuit (Closed Loop) Component Failure in the General Information section for information regarding the importance of removing contamination from the traction circuit.

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Gear Pump

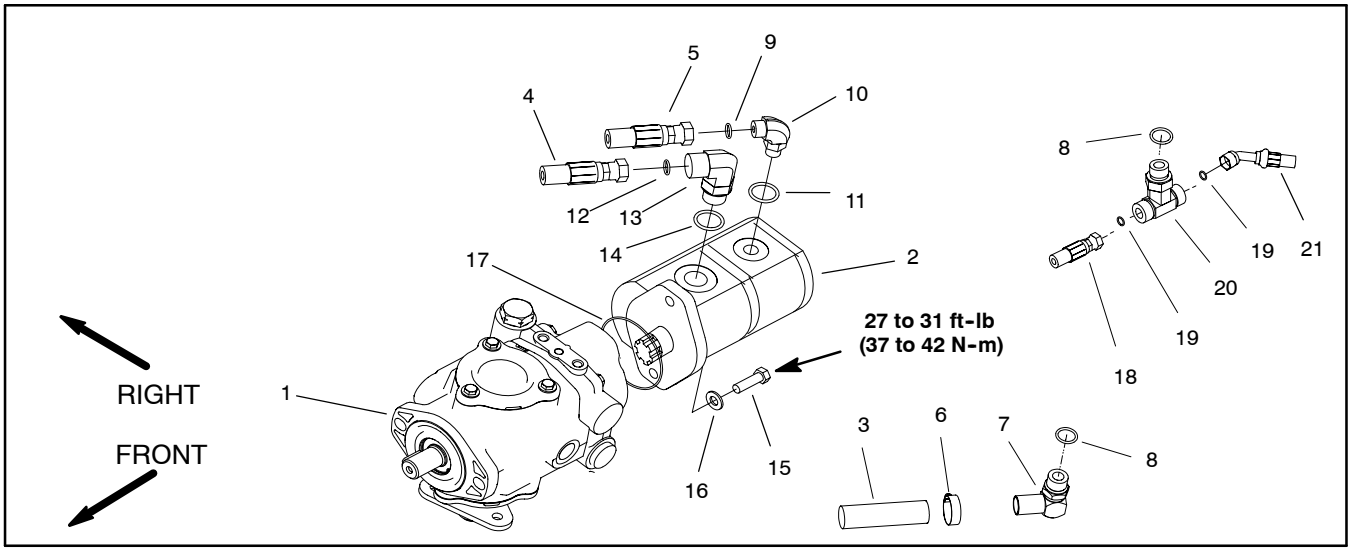

Figure 55

1. **Piston pump**
2. **Gear pump**
3. **Hydraulic hose (tank suction)**
4. **Hydraulic hose (hydraulic manifold)**
5. **Hydraulic hose (steering valve)**
6. **Hose clamp**
7. **Hydraulic barb fitting**
8. **O-ring**
9. **O-ring**
10. **90º hydraulic fitting**
11. **O-ring**
12. **O-ring**
13. **90º hydraulic fitting**
14. **O-ring**
15. **Cap screw (2 used)**
16. **Flat washer (2 used)**
17. **O-ring**
18. **Hydraulic hose (reservoir)**
19. **O-ring**
20. **Tee fitting**
21. **Hydraulic hose (oil filter)**

Removal (Fig. 55)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. Remove muffler from the engine to gain access to the gear pump (see Muffler Removal in the Service and Repairs section of Chapter 3 – Kubota Diesel Engine).

3. Drain hydraulic oil from hydraulic tank (see Traction Unit Operator's Manual).

4. Thoroughly clean hydraulic hose ends and fittings on gear pump to prevent hydraulic system contamination.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

5. Label all hydraulic hoses and fittings for assembly purposes.

6. Remove gear pump from the piston pump using Figure 55 as guide.

Installation (Fig. 55)

IMPORTANT: Position gear pump to the piston pump so that the gear pump suction port is facing down.

1. Install gear pump to the piston pump using Figure 55 as guide.

2. Fill hydraulic tank with **new** hydraulic fluid (see Traction Unit Operator's Manual).

3. Install muffler to the engine (see Muffler Installation in the Service and Repairs section of Chapter 3 – Kubota Diesel Engine).

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Gear Pump Service (Below Serial Number 260000400)

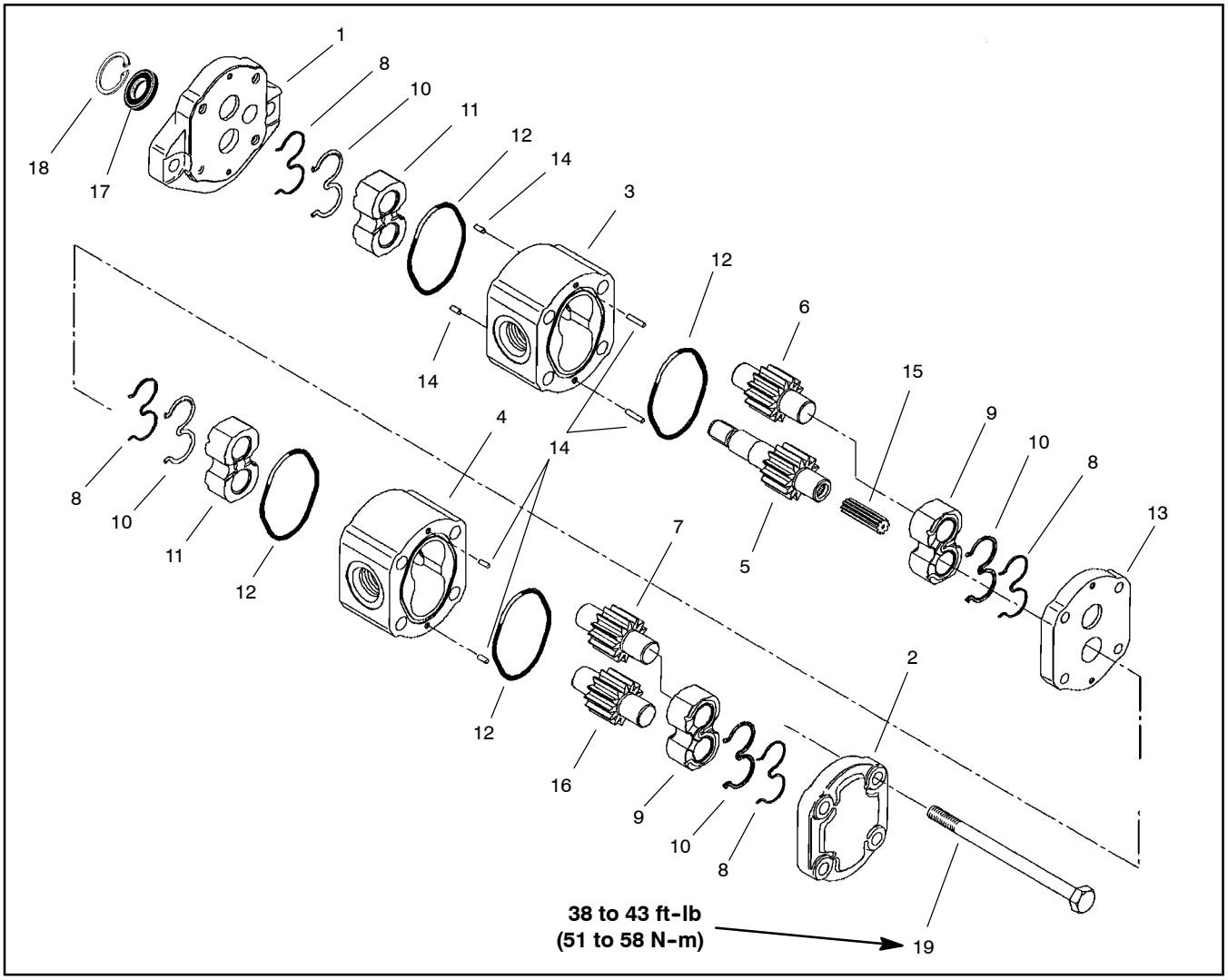

Figure 56

1. **Front plate**
2. **Back plate**
3. **Front body**
4. **Rear body**
5. **Drive gear**
6. **Front idler gear**
7. **Rear idler gear**
8. **Back-up gasket**
9. **Rear wear plate**
10. **Pressure seal**
11. **Front wear plate**
12. **O-ring**
13. **Adapter plate**
14. **Dowel**
15. **Coupler**
16. **Drive gear**
17. **Shaft seal (if equipped)**
18. **Retaining ring (if equipped)**
19. **Cap screw**

Disassembly (Fig. 56)

1. Plug pump ports and clean the outside of the pump thoroughly. After cleaning, remove plugs and drain any oil out of the pump.

2. Use a marker to make a **diagonal** line across the front plate, front body, adapter plate, rear body and back plate for assembly purposes (Fig. 57).

IMPORTANT: Avoid using excessive clamping pressure on the pump housing to prevent distorting the housing.

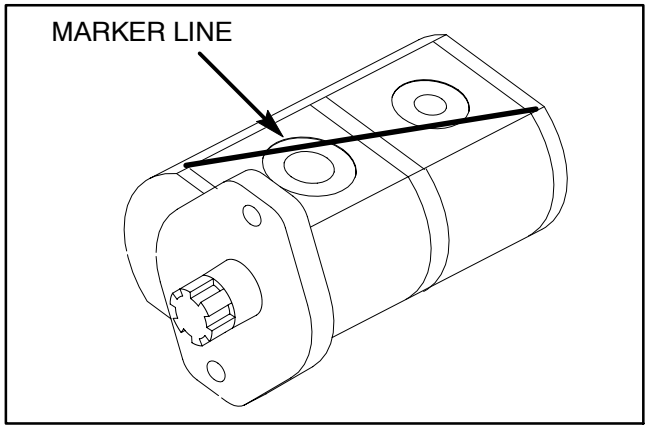

Figure 57

3. Clamp mounting flange of pump in a vise with the shaft end down.

4. Loosen cap screws from the back plate.

5. Remove pump from the vise. Turn pump so that the shaft end is facing down. Remove cap screws.

6. Remove back plate from the rear body.

7. Carefully remove rear body. Lift body straight up to remove. Make sure the rear wear plate remains on the drive and idler gear shafts. Remove and discard o−rings from the rear body.

IMPORTANT: Note position of the open and closed side of the wear plates before removing from the adapter plate. Also, identify wear plates (front and rear) for proper reassembly. Do not scribe on wear plates.

8. Carefully remove rear wear plate, idler gear, drive gear and front wear plate from the adapter plate.

9. Remove coupler from the drive gear shaft.

10. Remove adapter plate.

11. Carefully remove front body. Lift body straight up to remove. Make sure the rear wear plate remains on the drive and idler gear shafts. Remove and discard o−rings from the front body.

IMPORTANT: Note position of the open and closed side of the wear plates before removing from the front plate. Also, identify wear plates (front and rear) for proper reassembly. Do not scribe on wear plates.

12. Carefully remove rear wear plate, idler gear, drive gear and front wear plate from front plate.

13. Remove back−up gasket and pressure seal from all wear plates.

NOTE: Gear pumps on early production machines may have had a shaft seal and retaining ring in the front plate. Pumps used on later production machines did not have a seal or retaining ring. The seal and retaining ring are not needed on any Groundsmaster 3505−D.

14. If retaining ring and seal exist in front plate, remove them from the front plate. Make sure to not damage the front plate counter bore when removing components.

15. Discard all removed seals and gaskets.

Inspection (Fig. 56)

1. Remove all nicks and burrs from all pump parts with emery cloth.

CAUTION

Use eye protection such as goggles when using compressed air.

2. Clean all parts with solvent. Dry all parts with compressed air.

3. Inspect drive gears and idler gears for the following (Fig. 58):

A. Drive gear shaft spline should be free of twisted or broken teeth.

B. Gear shafts should be free of rough surfaces and excessive wear at bushing points and sealing areas. Scoring, rough surfaces or wear on gear shafts indicates need for replacement.

C. Gear teeth should be free of excessive scoring and wear. Any broken or nicked gear teeth must be replaced.

D. Inspect gear face edge for sharpness. Sharp edges of gears will mill into wear plates and, thus, must be replaced.

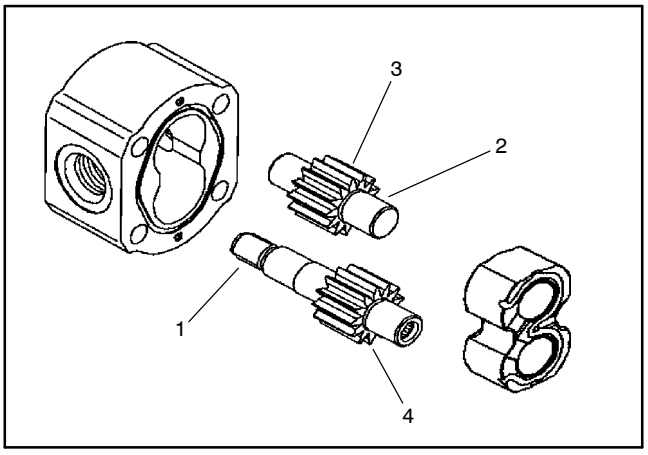

Figure 58

1. **Gear shaft spline**
2. **Gear shaft**
3. **Gear teeth**
4. **Gear face edge**

4. Inspect gear bodies for excessive scoring, gouges or wear. Evidence of damage indicates need for component replacement.

5. Inspect wear plates for the following:

   A. Bearing areas should not have excessive wear or scoring.

   B. Face of wear plates that are in contact with gears should be free of wear, roughness or scoring.

   C. Thickness of wear plates should be equal.

6. Inspect front plate, back plate and adapter plate for damage or wear.

Assembly (Fig. 56)

NOTE: When assembling the pump, check the marker line on each part to make sure the parts are properly aligned during assembly (Fig. 57).

1. Lubricate o-rings, pressure seals, back-up gaskets and wear plates with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic oil.

NOTE: A seal and retaining ring are not necessary in the front plate. The gear pump seal kit does not include these parts.

2. Place front plate on a flat surface with the internal machined surface facing up.

3. Apply a light coating of petroleum jelly to the pressure seals, back-up gaskets and wear plate grooves.

4. Install the pressure seals, flat side outward, into the grooves in the wear plates. Follow by carefully placing the backup gaskets, flat side outward, between the pressure seals and the groove in the wear plate.

5. Apply a light coating of petroleum jelly to the exposed side of the front plate.

6. Lubricate the drive gear shaft with clean hydraulic oil. Insert the drive end of the drive shaft through the wear plate with the pressure seal side down and the open side of the pressure seal pointing to the suction side of the pump. Carefully install shaft into front plate.

7. Lubricate the front idler gear shaft with clean hydraulic oil. Install idler gear shaft into the remaining position in the wear plate. Apply a light coating of clean hydraulic oil to gear faces.

8. Install rear wear plate with pressure seal side up and open side of the pressure seal pointing to the suction side of the pump.

9. Apply a light coating of petroleum jelly to new o-rings and o-ring grooves in the front body. Install new o-rings to the front body.

10. Install locating dowels in front body. Align marker line on the front body and front plate (Fig. 57).

IMPORTANT: Do not dislodge pressure seals, back-up gaskets or o-rings during pump assembly.

11. Gently slide the front body onto the assembly. Firm hand pressure should be sufficient to engage the dowels.

12. Check to make sure that the surface of the wear plate is slightly below the face of the front body. If the wear plate is not below the front body, check assembly for a shifted pressure seal or o-ring. Correct before proceeding.

13. Apply a light coating of petroleum jelly to the exposed side of the adapter plate.

14. Place adapter plate on assembly using marker line for proper location (Fig. 57). Firm hand pressure should be sufficient to engage the dowels.

15. Install coupler into drive gear.

16. Follow above procedure to install back section of the pump using the same precautions, lubrication and alignment.

17. Install the four screws and hand tighten.

18. Place mounting flange of the pump into a vise and alternately torque the screws from 38 to 43 ft-lb (51 to 58 N-m).

19. Remove pump from vise.

20. Place a small amount of clean hydraulic oil in the inlet of the pump and rotate the drive shaft away from the inlet one revolution. If any binding is noted, disassemble the pump and check for assembly problems.

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Gear Pump Service (Serial Numbers Above 260000400)

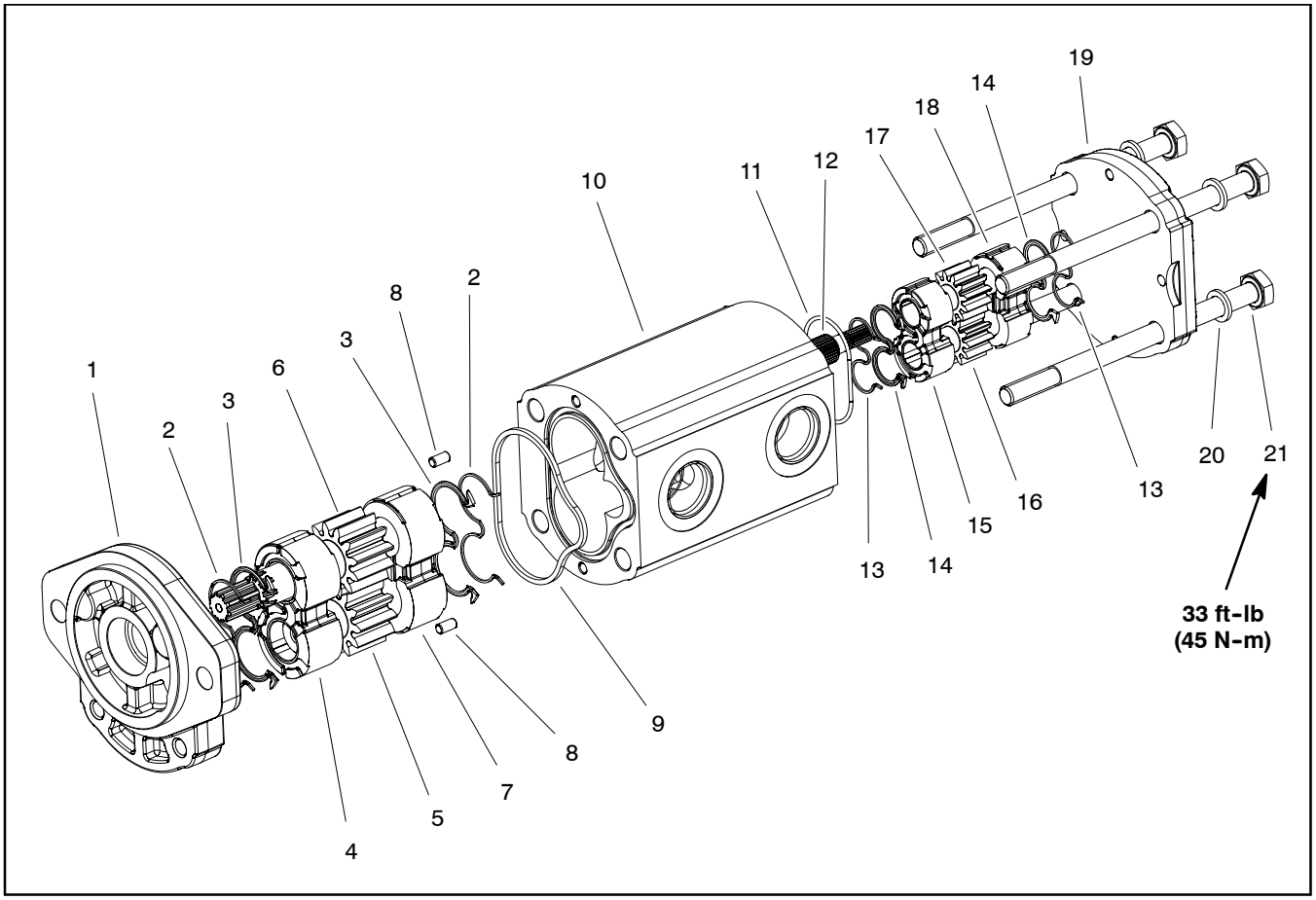

Figure 33

1. **Front cover**
2. **Pressure seal**
3. **Back-up gasket**
4. **Front thrust plate**
5. **Idler gear**
6. **Drive shaft**
7. **Rear thrust plate**
8. **Dowel pin**
9. **Seal**
10. **Body**
11. **Seal**
12. **Splined connecting shaft**
13. **Pressure seal**
14. **Back-up gasket**
15. **Front thrust plate**
16. **Idler gear**
17. **Drive gear**
18. **Rear thrust plate**
19. **Rear cover**
20. **Washer (4 used)**
21. **Cap screw (4 used)**

Disassembly (Fig. 33)

NOTE: The gear pump must be replaced as a complete assembly. Individual gears, housings and thrust plates are not available separately. Disassemble gear pump for cleaning, inspection and seal replacement only.

1. Plug pump ports and thoroughly clean exterior of pump with cleaning solvent. Make sure work area is clean.

2. Use a marker to make a **diagonal** line across the gear pump for assembly purposes (Fig. 34).

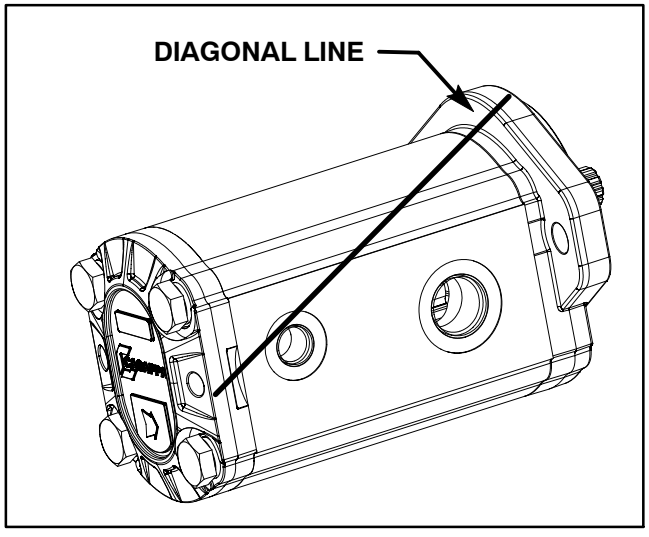

Figure 34

IMPORTANT: Use caution when clamping gear pump in a vise to avoid distorting any pump components.

3. Secure the front cover of the pump in a vise with the drive shaft pointing down.

4. Loosen the four (4) cap screws that secure pump assembly.

5. Remove pump from vise and remove fasteners.

6. Support the pump assembly and gently tap the pump case with a soft face hammer to loosen the pump sections. Be careful to not drop parts or disengage gear mesh.

IMPORTANT: Mark the relative positions of the gear teeth and the thrust plates so they can be reassembled in the same position. Do not touch the gear surfaces as residue on hands may be corrosive to gear finish.

7. Remove the thrust plates and seals from each pump section. Before removing each gear set, apply marking dye to mating teeth to retain "timing". Pump efficiency may be affected if the teeth are not installed in the same position during assembly. Keep the parts for each pump section together; do not mix parts between sections.

8. Clean all pump parts. Check all components for burrs, scoring, nicks and other damage.

9. Replace the entire pump assembly if parts are excessively worn or scored.

Assembly (Fig. 33)

1. Apply clean hydraulic oil to all parts before assembling.

NOTE: Pressure seals and back-up gaskets fit in grooves machined into thrust plates. Body seals fit in grooves machined in body faces.

2. Assemble pump sections starting at front cover end. Apply grease or petroleum jelly to new section seals to hold them in position during gear pump assembly.

3. After pump has been assembled, tighten cap screws by hand. Rotate the drive shaft to check for binding. Protect the shaft if using a pliers to rotate shaft.

4. Tighten the four (4) cap screws evenly in a crossing pattern to a torque of 33 ft-lb (45 N-m).

Steering Control Valve

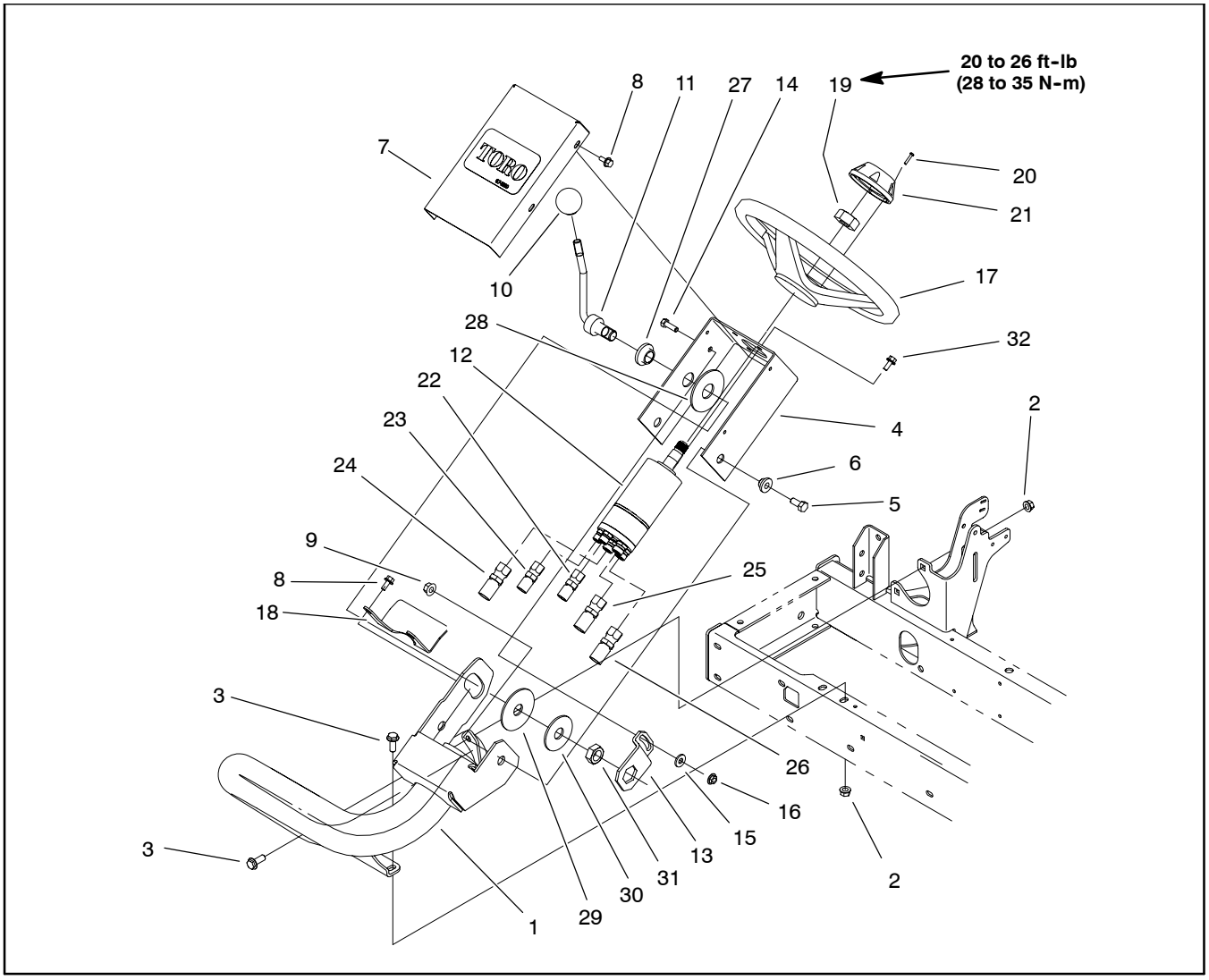

Figure 59

1. Steering arm
2. Flange nut
3. Flange head screw
4. Steering valve bracket
5. Cap screw (2 used)
6. Pivot hub (2 used)
7. Steering cover
8. Cap screw
9. Flange nut (2 used)
10. Ball knob
11. Steering tilt lever
12. Steering control valve
13. Tilt bracket
14. Cap screw
15. Flat washer
16. Flange nut
17. Steering wheel
18. Steering shield
19. Steering wheel nut
20. Phillips head screw
21. Steering wheel cap
22. Hydraulic hose
23. Hydraulic hose
24. Hydraulic hose
25. Hydraulic hose
26. Hydraulic hose
27. Tilt steering boss
28. Friction disc
29. Friction disc
30. Flat washer
31. Jam nut
32. Flange head screw (4 used)

Removal (Fig. 59)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. Thoroughly clean hydraulic hose ends and fittings on steering control valve to prevent hydraulic system contamination.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

3. Label all hydraulic hoses and fittings for assembly purposes. Note port identification on steering control valve (Fig. 61).

4. Remove steering control valve from the steering column using Figures 59 and 60 as guides.

Installation (Fig. 59)

1. Install steering control valve to the steering column using Figures 59 and 60 as guides. Use labels placed during the removal process to properly install hoses to control valve.

2. Make sure hydraulic tank is full. Add correct oil if necessary (see Traction Unit Operator's Manual).

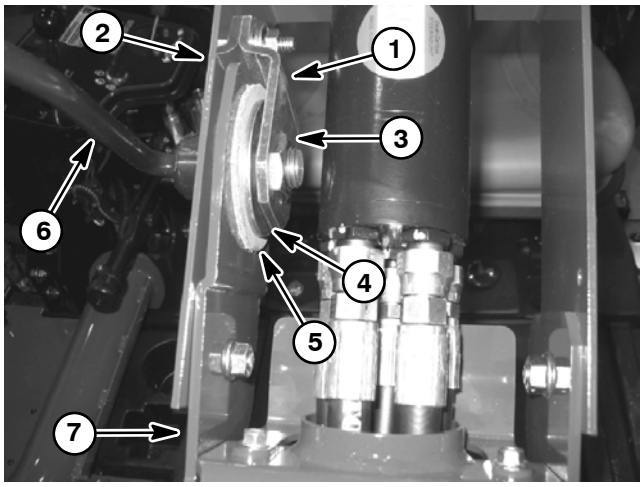

Figure 60

1. **Tilt bracket**
2. **Steering valve bracket**
3. **Jam nut**
4. **Flat washer**
5. **Friction disc**
6. **Steering tilt lever**
7. **Steering arm**

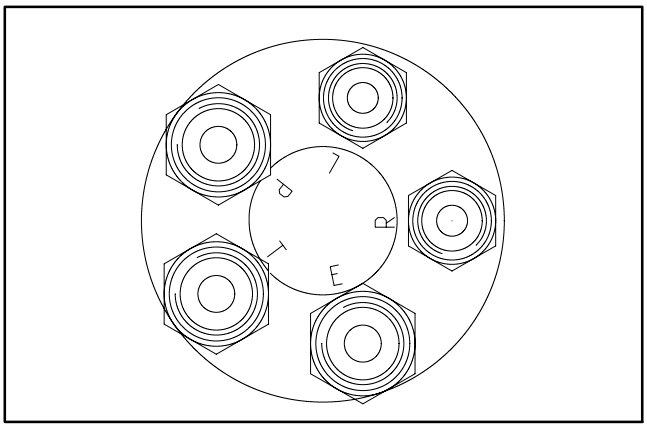

Figure 61

Steering Control Valve Service

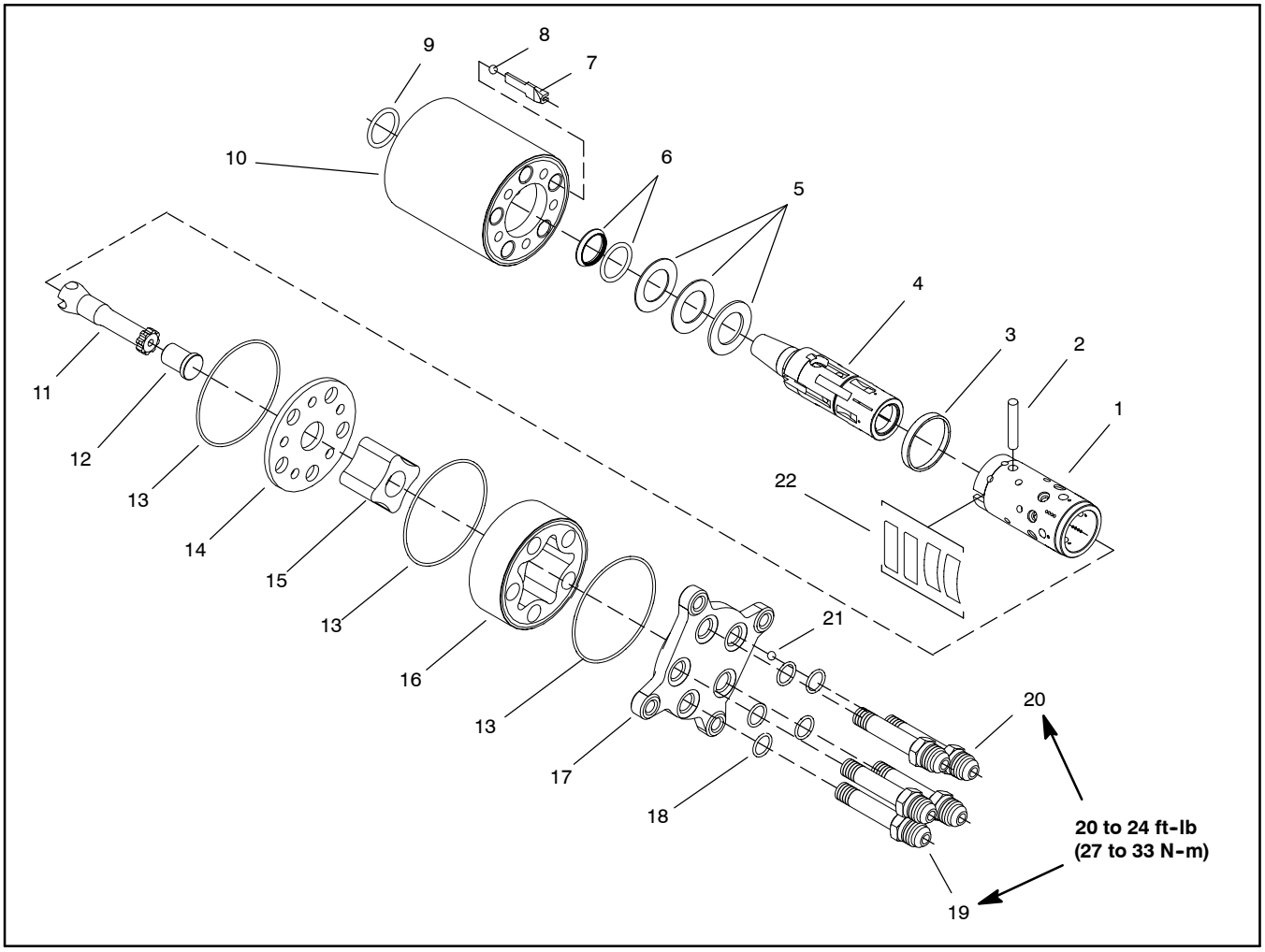

Figure 62

1. **Sleeve**
2. **Cross pin**
3. **Ring**
4. **Spool**
5. **Bearing assembly**
6. **Shaft seal**
7. **Ball stop**
8. **Ball**
9. **Dust seal ring**
10. **Housing**
11. **Cardan shaft**
12. **Spacer**
13. **O-ring**
14. **Distribution plate**
15. **Inner gearwheel**
16. **Outer gearwheel**
17. **End cover**
18. **O-ring (5 used)**
19. **Screw/fitting (ports L, R, T)**
20. **Screw/fitting (ports P and E)**
21. **P port check ball**
22. **Spring set**

NOTE: For service of the steering control valve, see the Sauer/Danfoss Steering Unit Type OSPM Service Manual at the end of this chapter.

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Front Lift Cylinder

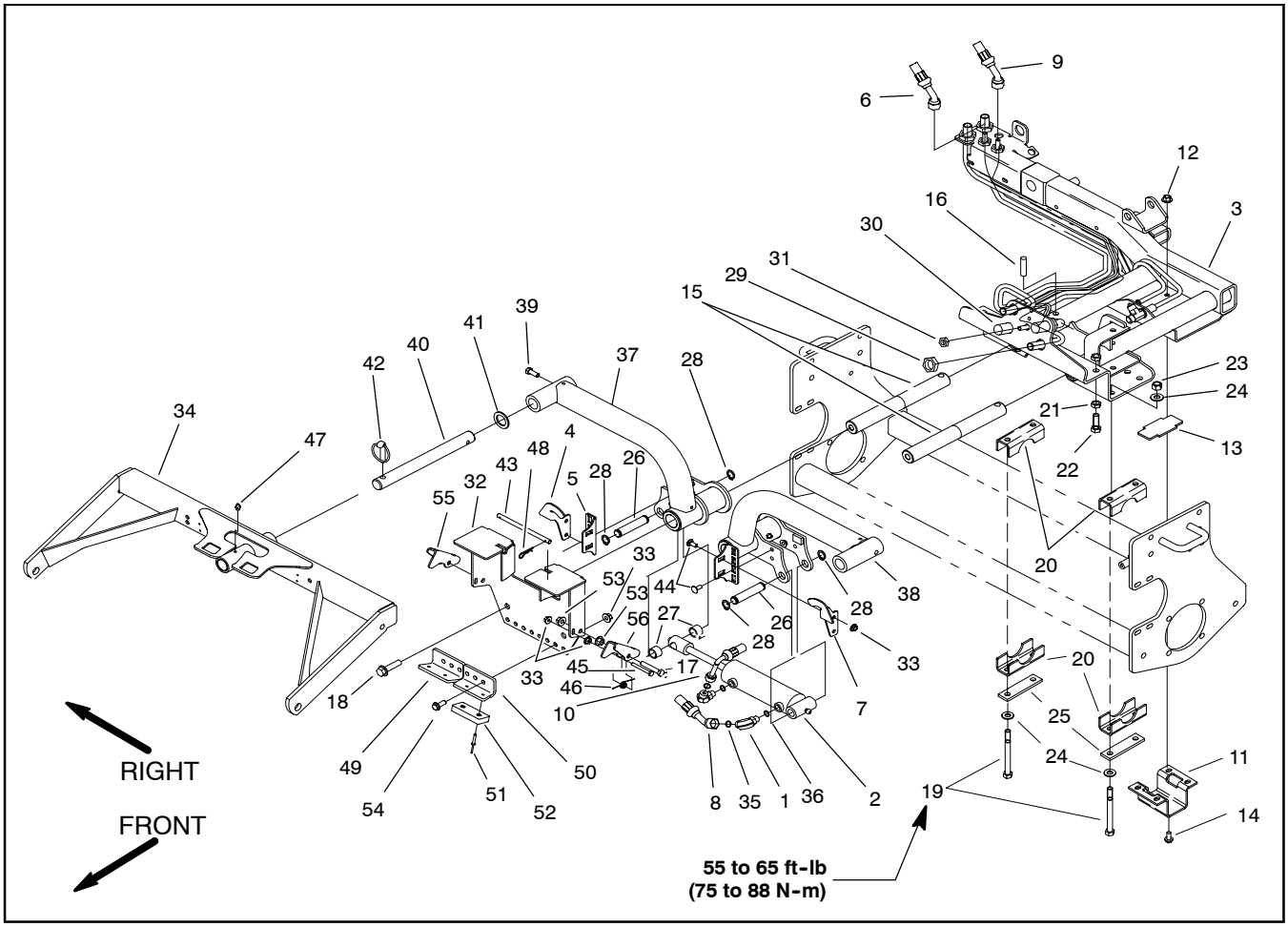

Figure 63

1. 90º hydraulic fitting (2 used)
2. Hydraulic cylinder
3. Carrier assembly
4. RH actuator
5. Actuator bracket
6. Hydraulic hose
7. LH actuator
8. Hydraulic hose
9. Hydraulic hose
10. Hydraulic hose
11. Clamp bracket
12. Flange nut (12 used)
13. Plastic slide
14. Flange head screw (4 used)
15. Lift arm pivot shaft
16. Roll pin (2 used)
17. Cap screw (2 used)
18. Flange head screw (2 used)
19. Cap screw (4 used)
20. Clamp (4 used)
21. Jam nut (4 used)
22. Cap screw (2 used)
23. Lock nut (4 used)
24. Thrust washer (8 used)
25. Support bar
26. Pin (2 used)
27. Spacer (2 used)
28. External retaining ring (4 used)
29. Bulkhead nut (4 used)
30. Hydraulic tube
31. Bulkhead nut
32. Carrier stop bracket
33. Nut (12 used)
34. Front carrier frame (2 used)
35. O-ring (2 used)
36. O-ring (2 used)
37. RH liftarm
38. LH liftarm
39. Cap screw (2 used)
40. Pivot shaft (2 used)
41. Thrust washer (2 used)
42. Lynch pin (2 used)
43. Rod
44. Carriage screw (8 used)
45. Cap screw (2 used)
46. Torsion spring (2 used)
47. Grease fitting (2 used)
48. Hair pin (2 used)
49. RH deck stop
50. LH deck stop
51. Rivet (4 used)
52. Rubber bumper (2 used)
53. Flange nut (12 used)
54. Flange head screw (4 used)
55. RH pivot bracket
56. LH pivot bracket

Removal (Fig. 63)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. Thoroughly clean hydraulic hose ends and fittings on lift cylinder to prevent hydraulic system contamination.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

3. Remove front lift cylinder from the lift arms and machine using Figure 63 as guide.

4. If hydraulic fittings are to be removed from lift cylinder, mark fitting orientation to allow correct assembly.

Installation (Fig. 63)

IMPORTANT: With lift arms raised fully, hydraulic hoses should be routed as shown (Fig. 64). Make sure clearance between hydraulic hose and lift arm is from 0.040" to 0.120" (1.0 to 3.0 mm). Do not loosen hoses for repositioning without lowering cutting units and relieving system hydraulic pressure first.

1. If fittings were removed, install fittings to lift cylinder using marks made during the removal process to properly orientate fittings.

2. Install front lift cylinder to the lift arms and machine using Figure 63 as guide.

3. Make sure hydraulic tank is full. Add correct oil if necessary (see Traction Unit Operator's Manual).

4. Adjust front lift arms (see Traction Unit Operator's Manual).

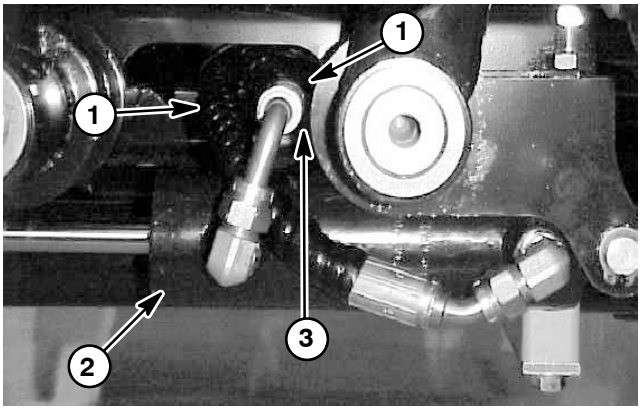

Figure 64

1. Hydraulic hose
2. Hydraulic cylinder
3. Clearance

Rear Lift Cylinder

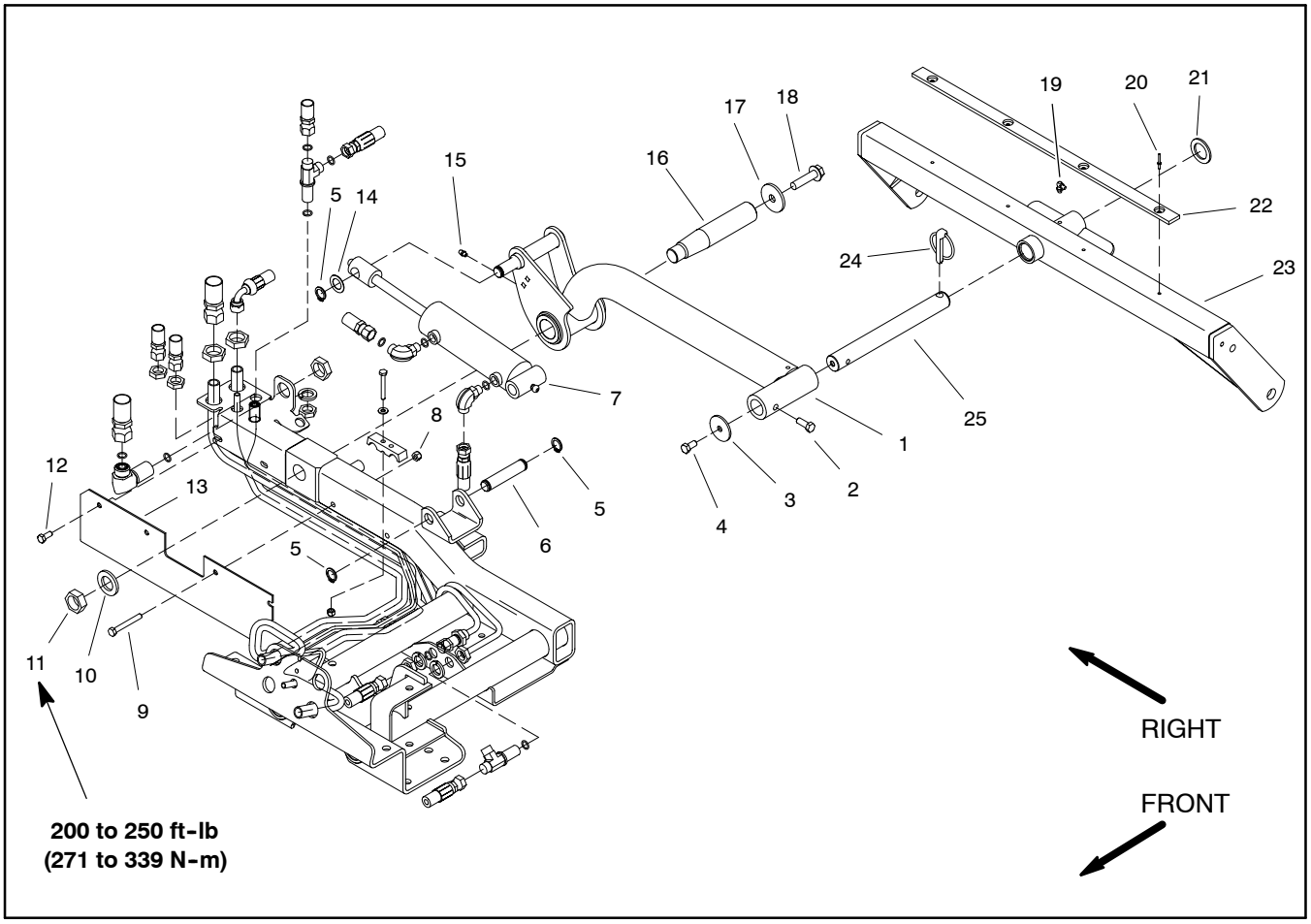

Figure 65

1. Rear lift arm
2. Cap screw
3. Washer
4. Cap screw
5. Retaining ring (3 used)
6. Pin
7. Hydraulic lift cylinder
8. Flange nut (4 used)
9. Cap screw (2 used)
10. Washer
11. Jam nut
12. Cap screw (2 used)
13. Guard
14. Thrust washer
15. Grease fitting
16. Pivot shaft
17. Thrust washer
18. Flange screw
19. Grease fitting
20. Pop rivet (4 used)
21. Thrust washer
22. Wear strip
23. Rear carrier frame
24. Lynch pin
25. Pivot shaft

Removal (Fig. 65)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. Thoroughly clean hydraulic hose ends and fittings on lift cylinder to prevent hydraulic system contamination.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

3. Remove rear lift cylinder from the frame and lift arm using Figure 65 as guide.

4. If hydraulic fittings are to be removed from lift cylinder, mark fitting orientation to allow correct assembly.

Installation (Fig. 65)

1. If fittings were removed, install fittings to lift cylinder using marks made during the removal process to properly orientate fittings.

2. Install rear lift cylinder to the frame and lift arm using Figure 65 as guide.

3. Make sure hydraulic tank is full. Add correct oil if necessary (see Traction Unit Operator's Manual).

4. Adjust rear lift arm (see Traction Unit Operator's Manual).

Lift Cylinder Service

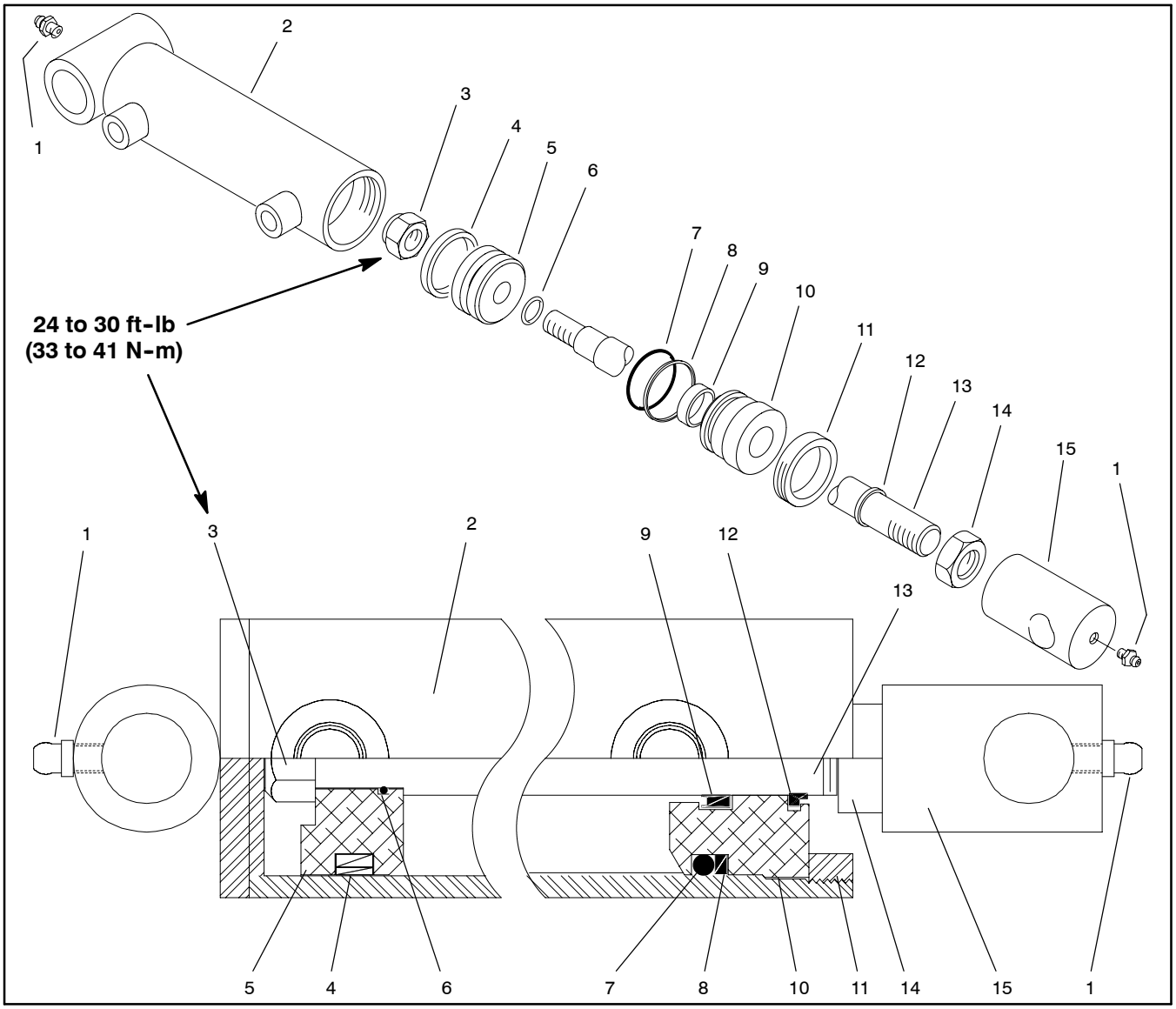

Figure 66

1. Grease fitting
2. Barrel with clevis
3. Lock nut
4. Uni-ring
5. Piston
6. O-ring
7. O-ring
8. Back-up ring
9. Rod seal
10. Head
11. Internal collar
12. Dust seal
13. Shaft
14. Jam nut
15. Clevis

Disassembly (Fig. 66)

1. Remove oil from lift cylinder into a drain pan by slowly pumping the cylinder shaft. Plug both ports and clean the outside of the cylinder.

IMPORTANT: Prevent damage when clamping the hydraulic cylinder into a vise; clamp on the clevis ONLY.

2. Mount lift cylinder in a vise. Remove internal collar with a spanner wrench.

3. Remove plugs from ports. Extract shaft, head and piston by carefully twisting and pulling on the shaft.

IMPORTANT: Do not clamp vise jaws against the shaft surface. Clamp on the clevis ONLY.

4. Mount shaft securely in a vise by clamping on the clevis of the shaft. Remove lock nut and piston from the shaft. Slide head off the shaft.

5. Remove Uni-ring and o-ring from the piston. Remove o-ring, back-up ring, rod seal and dust seal from the head.

Assembly (Fig. 66)

1. Make sure all parts are clean before reassembly.

2. Coat new o-rings, Uni-ring, rod seal, back-up ring and dust seal with clean hydraulic oil.

   A. Install Uni-ring and o-ring to the piston.

   B. Install dust seal, o-ring, back-up ring and dust seal to the head.

IMPORTANT: Do not clamp vise jaws against the shaft surface. Clamp on the clevis ONLY.

3. Mount shaft securely in a vise by clamping on the clevis of the shaft.

   A. Coat shaft with clean hydraulic oil.

   B. Slide head onto the shaft. Install rod seal onto shaft and into head.

   C. Install piston and lock nut onto the shaft. Torque lock nut from 24 to 30 ft-lb (33 to 41 N-m).

   D. Remove shaft from the vise.

IMPORTANT: Prevent damage when clamping the hydraulic cylinder into a vise; clamp on the clevis ONLY.

4. Mount barrel in a vise.

5. Coat all internal parts with a light coat of clean hydraulic oil. Slide piston, shaft and head assembly into the barrel being careful not to damage the seals.

6. Secure head in the barrel with internal collar using a spanner wrench. Tighten collar until snug and the outer end of the collar is flush with end of the barrel.

7. If clevis was removed from cylinder shaft, fully retract cylinder shaft and thread jam nut and clevis onto shaft. Adjust center to center length to dimension shown in Figure 67 before tightening jam nut.

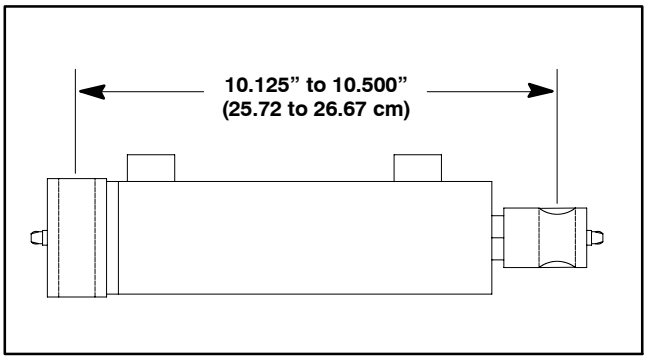

Figure 67

Steering Cylinder

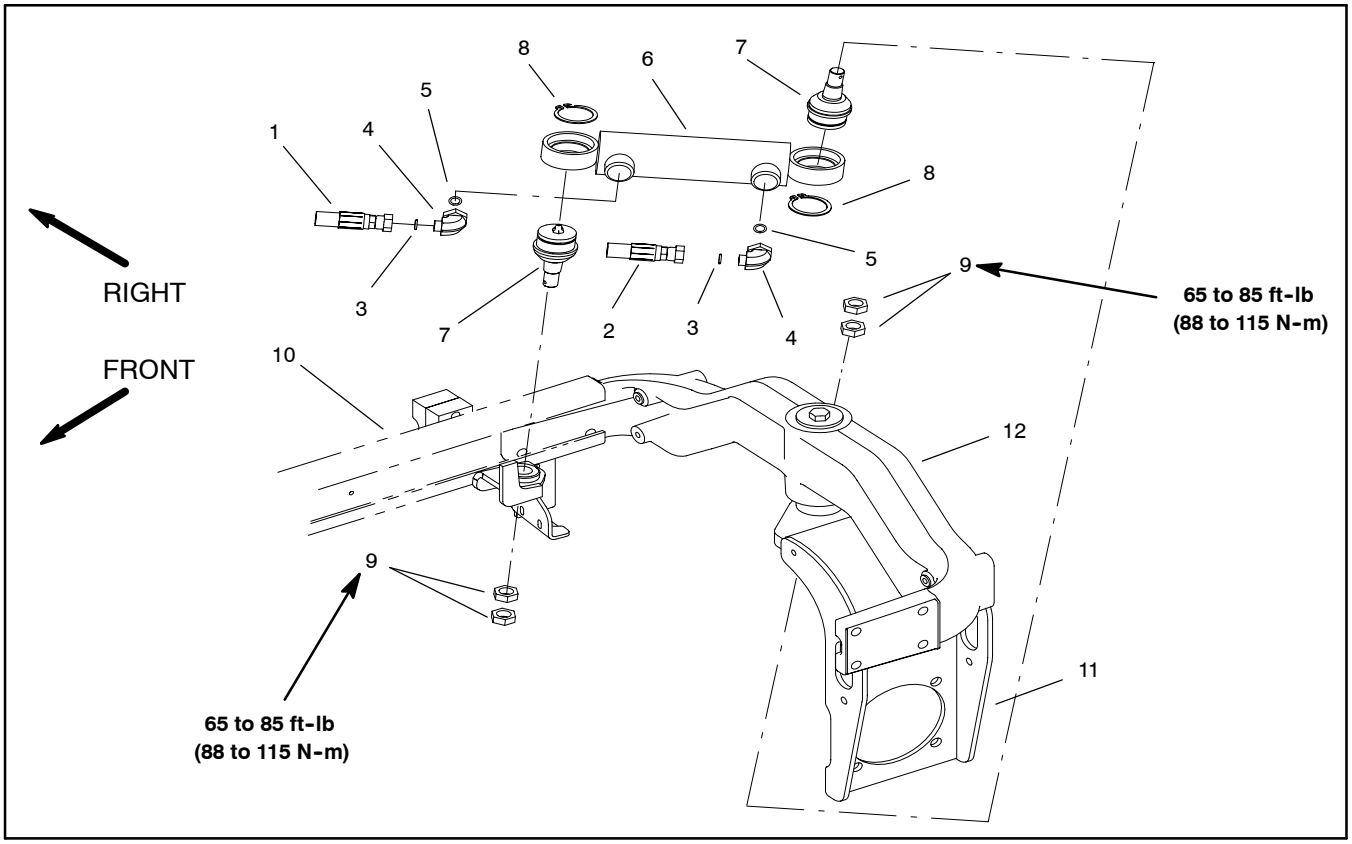

Figure 68

1. **Hydraulic hose**
2. **Hydraulic hose**
3. **O-ring**
4. **Hydraulic fitting**
5. **O-ring**
6. **Steering cylinder**
7. **Ball joint**
8. **Retaining ring**
9. **Jam nut**
10. **Frame**
11. **Rear fork**
12. **Rear casting**

Removal (Fig. 68)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

NOTE: The rear tire must be removed to allow sufficient clearance to remove the steering cylinder from the machine.

WARNING

Before jacking up the machine, review and follow Jacking Instructions in Chapter 1 – Safety.

2. Jack or lift rear wheel off the ground.

3. Remove rear wheel from the drive studs and wheel hub.

4. Thoroughly clean hydraulic hose ends and fittings on steering cylinder to prevent hydraulic system contamination.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

5. Remove steering cylinder from the frame and rear fork using Figure 68 as guide.

6. If hydraulic fittings are to be removed from steering cylinder, mark fitting orientation to allow correct assembly.

Installation (Fig. 68)

1. If fittings were removed from steering cylinder, install fittings to cylinder using marks made during the removal process to properly orientate fittings.

2. Install steering cylinder to the frame and rear fork using Figure 68 as guide. When securing cylinder ball joints to machine, tighten the first jam nut from 65 to 85 ft–lb (88 to 115 N–m), then tighten the second jam nut to the same specification.

3. Mount rear wheel to the machine with four (4) lug nuts. Lower machine to the ground. Torque lug nuts in a crossing pattern from 45 to 65 ft–lb (61 to 88 N–m).

4. Make sure hydraulic tank is full. Add correct oil if necessary (see Traction Unit Operator's Manual).

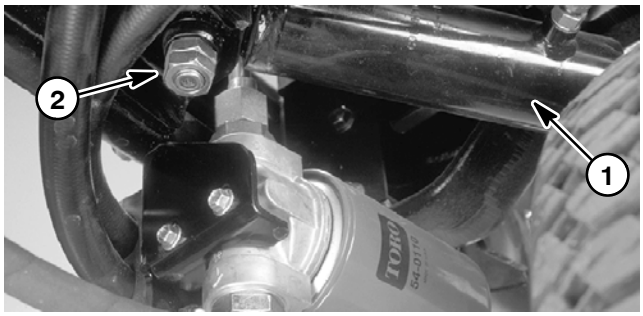

Figure 69

1. **Steering cylinder**
2. **Jam nuts**

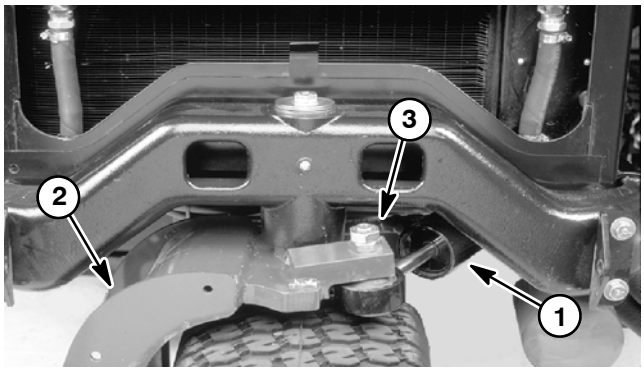

Figure 70

1. **Steering cylinder**
2. **Rear fork**
3. **Jam nuts**

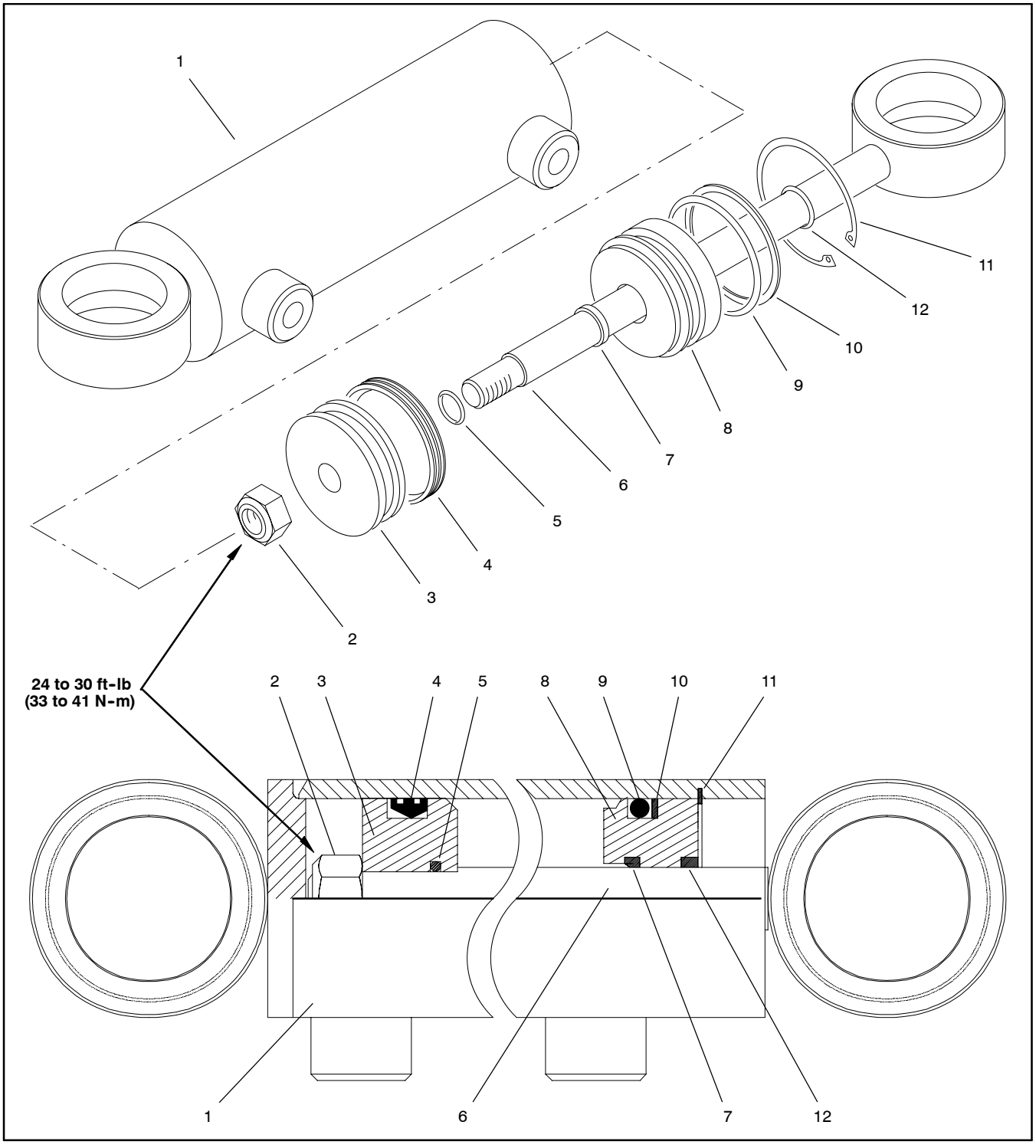

Figure 71

1. **Barrel with clevis**
2. **Lock nut**
3. **Piston**
4. **Uni-ring**
5. **O-ring**
6. **Piston rod**
7. **Rod seal**
8. **Cylinder gland**
9. **O-ring**
10. **Back-up ring**
11. **Retaining ring**
12. **Dust seal**

Disassembly (Fig. 71)

1. Remove oil from the steering cylinder into a drain pan by slowly pumping the cylinder shaft. Plug both ports and clean the outside of the cylinder.

IMPORTANT: Prevent damage when clamping the hydraulic cylinder into a vise; clamp on the clevis ONLY.

2. Mount clevis end of steering cylinder in a vise. Remove retaining ring.

3. Remove plugs from ports. Extract shaft, cylinder gland and piston by carefully twisting and pulling on the shaft.

IMPORTANT: Do not clamp vise jaws against the shaft surface. Clamp on the clevis ONLY.

4. Mount shaft securely in a vise by clamping on the clevis of the shaft. Remove lock nut and piston from the shaft. Slide cylinder gland off the shaft.

5. Remove Uni−ring and o−ring from the piston.

6. Remove back−up ring, o−rings and rod seal from the cylinder gland.

Assembly (Fig. 71)

1. Make sure all parts are clean before reassembly.

2. Coat new o−rings, Uni−ring, rod seal and back−up ring with clean hydraulic oil.

   A. Install Uni−ring and o−ring to the piston.

   B. Install o−rings, back−up ring and rod seal to the cylinder gland.

IMPORTANT: Do not clamp vise jaws against the shaft surface. Clamp on the clevis ONLY.

3. Mount shaft securely in a vise by clamping on the clevis of the shaft.

   A. Coat shaft with a light coat of clean hydraulic oil.

   B. Slide cylinder gland assembly onto the shaft. Install piston and lock nut onto the shaft. Torque nut from 24 to 30 ft−lb (33 to 41 N−m).

   C. Remove shaft from the vise.

IMPORTANT: Prevent damage when clamping the hydraulic cylinder into a vise; clamp on the clevis ONLY.

4. Mount clevis of the barrel in a vise.

5. Coat all internal parts with a light coat of clean hydraulic oil. Slide piston, shaft and cylinder gland assembly into the barrel being careful not to damage the seals.

6. Secure head into the barrel with the retaining ring.

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Chapter 5

Electrical System

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Electrical Schematics and Diagrams

The electrical schematics and other electrical drawings for the Groundsmaster 3505–D are located in Chapter 8 – Electrical Diagrams.

Special Tools

Order special tools from your Toro Distributor. Some tools may also be available from a local supplier.

Multimeter

The multimeter can test electrical components and circuits for current, resistance or voltage.

NOTE: Toro recommends the use of a DIGITAL Volt–Ohm–Amp multimeter when testing electrical circuits. The high impedance (internal resistance) of a digital meter in the voltage mode will make sure that excess current is not allowed through the meter. This excess current can cause damage to circuits not designed to carry it.

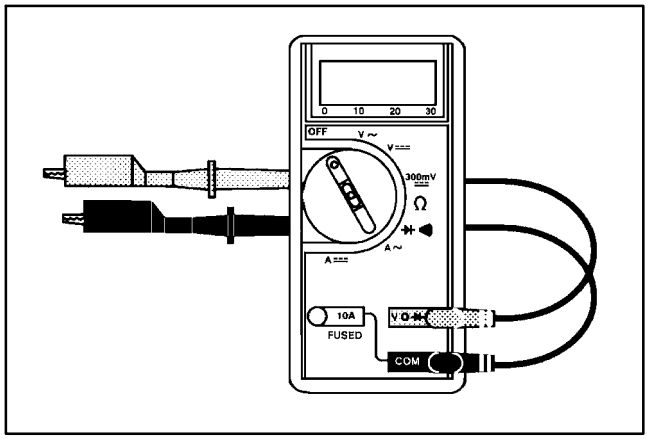

Figure 1

Skin–Over Grease

Special non–conductive grease (Toro Part No. 505–165) which forms a light protective skin to help waterproof electrical switches and contacts.

Figure 2

Battery Terminal Protector

Battery Terminal Protector (Toro Part No. 107–0392) is an aerosol spray that should be used on battery terminals to reduce corrosion problems. Apply terminal protector after battery cable has been secured to battery terminal.

Figure 3

Battery Hydrometer

Use the Battery Hydrometer when measuring specific gravity of battery electrolyte. Obtain this tool locally.

Figure 4

Troubleshooting

CAUTION

Remove all jewelry, especially rings and watches, before doing any electrical troubleshooting or testing. Disconnect the battery cables unless the test requires battery voltage.

For effective troubleshooting and repairs, you must have a good understanding of the electrical circuits and components used on this machine (see Electrical Diagrams – Chapter 8).

If the machine has any interlock switches by–passed, they must be reconnected for proper troubleshooting and safety.

NOTE: Use the Standard Control Module input and output LED's when troubleshooting a Groundsmaster 3505–D electrical problem.

Starting Problems

Problem	Possible Causes
Starter solenoid clicks, but starter will not crank (if solenoid clicks, problem is not in safety interlock system).	Low battery charge. Loose or corroded battery cables. Loose or corroded ground. Faulty wiring at the starter. Faulty starter solenoid.
Nothing happens when start attempt is made.	The traction pedal is not in neutral position or the traction neutral switch is faulty or out of adjustment. Parking brake is disengaged with seat unoccupied. PTO switch is in the ENGAGE position or is faulty. The engine is too hot or the over temperature shut down switch is faulty. The battery is dead. Fuse F1 or F3 is faulty or blown. Loose or corroded battery or ground cables. Loose or corroded ground. Wiring in the crank circuit is loose, corroded or damaged (see Electrical Diagrams – Chapter 8). The ignition switch is faulty. Starter solenoid wiring is loose, corroded or damaged. Starter solenoid is faulty. The standard control module is faulty.

Starting Problems (continued)

Problem	Possible Causes
Engine cranks, but does not start.	Wiring in the crank circuit is loose, corroded or damaged (see Electrical Diagrams – Chapter 8). Engine run solenoid or circuit wiring is faulty. Engine fuel pump or circuit wiring is faulty. The fuel tank is empty. An engine or fuel system problem exists. The glow circuit does not operate properly.
The glow circuit does not operate properly.	Wiring in the glow circuit (see Electrical Diagrams – Chapter 8) is loose, corroded or damaged. The glow relay or glow plug controller is faulty. Fuse F4 is blown or faulty.
Engine cranks (but should not) with the PTO switch in the ENGAGE position.	The PTO switch is faulty or short circuited. Short circuit in traction neutral switch circuit. The standard control module is faulty.

General Run and Transport Problems

Engine stops during operation (operator sitting on seat).	Operator moved too far forward on seat (seat switch is not depressed). The engine is too hot or the high temperature shut down switch is faulty. The parking brake was engaged or the parking brake switch is faulty. The seat switch is faulty. Fuse F1 or F3 is faulty or blown. The engine run solenoid or fuel pump failed. Wiring in the run circuit is broken or disconnected (see Electrical Diagrams – Chapter 8).
Battery does not charge.	Loose or broken wire(s) (see Electrical Diagrams – Chapter 8). Faulty alternator. Faulty battery. Alternator warning lamp is faulty. Alternator warning lamp wiring is loose, corroded or damaged.

Cutting Deck Operating Problems

The cutting units will not run with the mow/transport slide in MOW and the PTO switch in ENGAGE.	Wiring to the cutting unit drive circuit (see Electrical Diagrams – Chapter 8) is loose, corroded or damaged. The solenoid coil (R1) on the hydraulic manifold is faulty. The PTO switch is faulty. The mow/transport slide is faulty or misadjusted. Engine temperature is excessive (high temperature warning switch closed). High temperature warning switch or circuit wiring is faulty. The standard control module is faulty. Hydraulic solenoid valve R1 is faulty (see Chapter 4–Hydraulic System). There is insufficient hydraulic oil pressure to turn the cutting units (see Troubleshooting in Chapter 4–Hydraulic System).

Electrical System Quick Checks

Battery Test (Open Circuit Test)

Use a multimeter to measure the voltage between the battery terminals.

Set multimeter to the DC volts setting. The battery should be at a temperature of 60° to 100°F (16° to 38°C). The ignition key should be off and all accessories turned off. Connect the positive (+) meter lead to the positive battery post and the negative (–) meter lead to the negative battery post. Measure and record the battery voltage.

NOTE: This test provides a relative condition of the battery. Load testing of the battery will provide additional and more accurate information.

Voltage Measured	Battery Charge Level
12.68 V (or higher)	Fully charged (100%)
12.45 V	75% charged
12.24 V	50% charged
12.06 V	25% charged
11.89 V	0% charged

Charging System Test

This is a simple test used to determine if a charging system is functioning. It will tell you if the charging system has an output, but not its capacity.

Tool required: Digital multimeter set to DC volts.

Test instructions: Connect the positive (+) multimeter lead to the positive battery post and the negative (–) multimeter lead to the negative battery post. Keep the test leads connected to the battery posts and record the battery voltage.

NOTE: Upon starting the engine, the battery voltage will drop and then should increase once the engine is running.

NOTE: Depending upon the condition of the battery charge and battery temperature, the charging system voltage will increase at different rates as the battery charges.

Start the engine and run at high idle (3200 RPM). Allow the battery to charge for at least 3 minutes. Record the battery voltage.

After running the engine for at least 3 minutes, battery voltage should be at least 0.50 volt higher than initial battery voltage.

Example of a charging system that is functioning:

At least 0.50 volt over initial battery voltage.	
Initial Battery Voltage	= 12.30 v
Battery Voltage after 3 Minute Charge	= 12.85 v
Difference	= +0.55 v

Glow Plug System Test

This is a fast, simple test that can help to determine the integrity and operation of the Groundsmaster 3505–D glow plug system. The test should be run anytime hard starting (cold engine) is encountered on a diesel engine equipped with a glow plug system.

Tool(s) required: Digital multimeter and/or inductive Ammeter (AC/DC Current Transducer).

Test instructions: Properly connect the ammeter to the digital multimeter (refer to manufacturers' instructions).

Set the multimeter to the correct scale. With the ignition switch in the OFF position, place the ammeter pickup around the main glow plug power supply wire and read the meter prior to activating the glow plug system. Adjust the meter to read zero (if applicable). Activate the glow plug system (see Traction Unit Operator's Manual) and record the multimeter results.

The Groundsmaster 3505–D glow plug system should have a reading of approximately 27 Amps.

Check Operation of Interlock Switches

CAUTION

Do not disconnect safety switches. They are for the operator's protection. Check the operation of the interlock switches daily for proper operation. Replace any malfunctioning switches before operating the machine.

The Groundsmaster 3505–D is equipped with a Standard Control Module which monitors interlock switch operation. Information on this Module is described in the Traction Unit Operator's Manual and in the Component Testing section of this Chapter. Testing of individual interlock switches is included in the Component Testing section of this Chapter.

NOTE: The machine is equipped with an interlock switch on the parking brake. The engine will stop if the traction pedal is depressed with the parking brake engaged.

1. Make sure all bystanders are away from the area of operation. Keep hands and feet away from rotary decks.

2. With operator on the seat, the engine must not start with either the PTO switch in the ENGAGE position or the traction pedal depressed. Correct problem if not operating properly.

3. With operator on the seat, the traction pedal in neutral, the parking brake off and the PTO switch in the DISENGAGE position, the engine should start. Lift off the seat and slowly depress traction pedal, the engine should stop in one to three seconds. Correct problem if not operating properly.

Component Testing

For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g. unplug the ignition switch connector before doing a continuity check on the switch).

NOTE: For engine component testing information, see the Kubota Workshop Manual, Diesel Engine, 05 Series.

CAUTION

When testing electrical components for continuity with a multimeter (ohms setting), make sure that power to the circuit has been disconnected.

Ignition Switch

The ignition (key) switch has three positions: OFF, RUN and START (Fig. 5). The switch terminals are identified as shown in Figure 6.

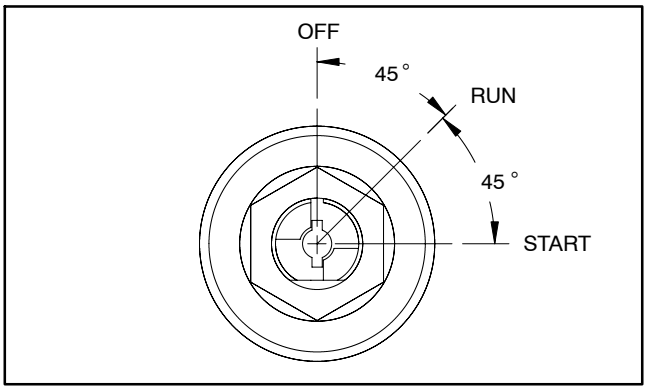

Figure 5

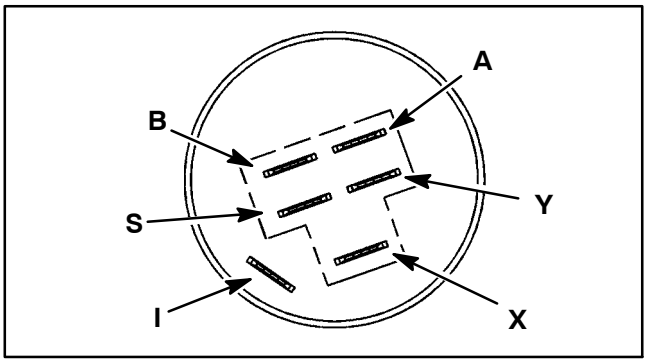

Figure 6

Testing

1. Make sure ignition switch is in the OFF position. Disconnect wire harness connector from ignition switch.

2. The circuitry of the ignition switch is shown in the chart below. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each switch position. Verify continuity between switch terminals.

SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
OFF	NONE	NONE
RUN	B + A + I	X + Y
START	B + S + I	NONE

Glow Relay

The glow relay used on the Groundsmaster 3505–D allows electrical current to the engine glow plugs when energized. The glow relay is attached to the radiator assembly.

Testing

1. Make sure ignition switch is in the OFF position. Unplug glow relay electrical connector.

NOTE: Prior to taking small resistance readings with a digital multimeter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from from the measured value of the component you are testing.

2. Verify coil resistance between terminals 85 and 86 with a multimeter (ohms setting). Resistance should be approximately 72 ohms.

3. Connect multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87 as +12 VDC is applied and removed from terminal 85.

4. Disconnect voltage and leads from the relay terminals.

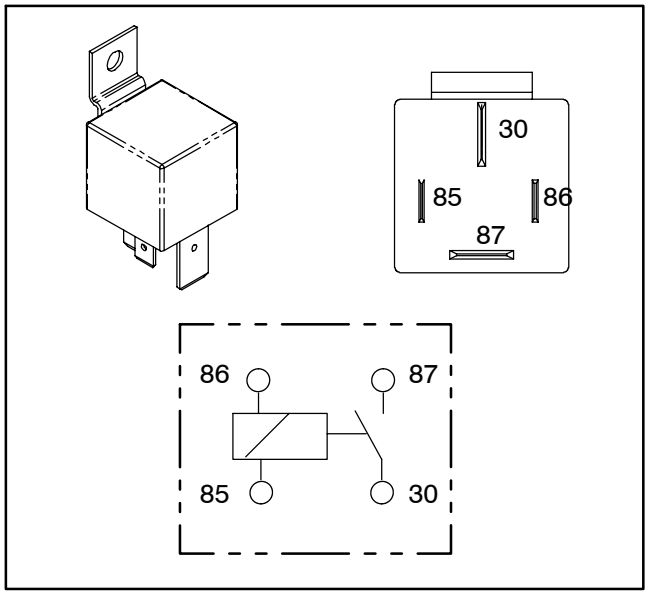

Figure 7

Hour Meter

1. Connect the positive (+) terminal of a 12 VDC source to the positive terminal of the hour meter.

2. Connect the negative (–) terminal of the voltage source to the other terminal of the hour meter.

3. The hour meter should move 1/10 of an hour in six minutes.

4. Disconnect the voltage source from the hour meter.

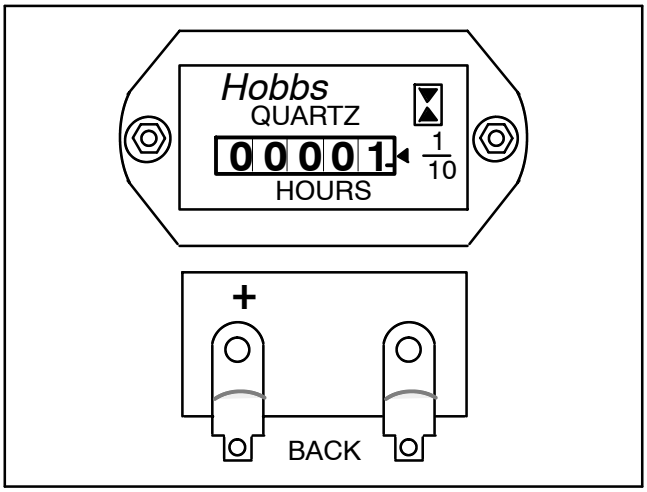

Figure 8

Solenoid Valve Coil

The hydraulic system on the Groundsmaster 3505–D uses a solenoid valve coil on the hydraulic manifold (Fig. 9). When the solenoid valve coil (R1) is energized, hydraulic flow is directed to the cutting decks.

The standard control module provides current to the solenoid valve coil based on the position of several inputs. A LED on the standard control module will be illuminated when the solenoid valve coil is energized.

Testing

NOTE: The solenoid does not have to be removed from the cartridge valve for testing.

1. Make sure ignition switch is in the OFF position. Unplug wire harness electrical connector from solenoid valve coil.

NOTE: Prior to taking small resistance readings with a digital multimeter, short the test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from from the measured value of the component you are testing.

2. Measure resistance between the two solenoid coil connector terminals. Resistance of the solenoid coil should be approximately 7.5 ohms.

3. Reconnect wire harness connector to the solenoid coil.

4. If solenoid coil needs replacement, see PTO Solenoid Valve Coil in the Service and Repairs section of this chapter.

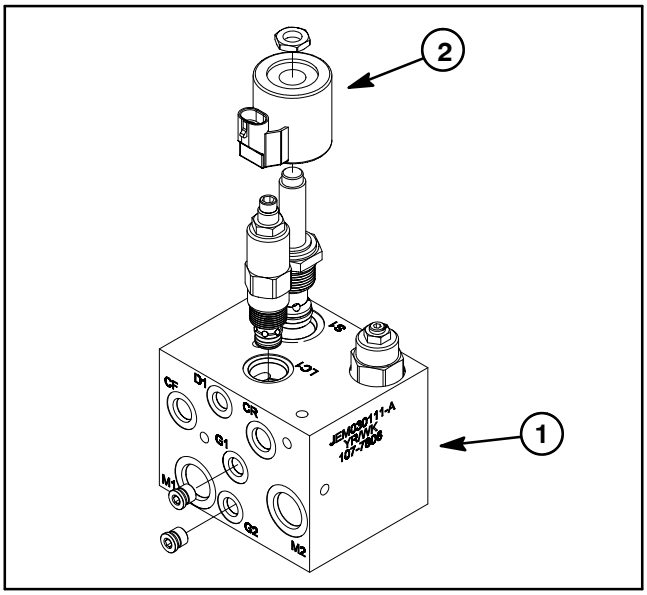

Figure 9

1. **Manifold assembly**
2. **Solenoid valve coil**

Indicator Lights

Charge Indicator Light

The charge indicator light should come on when the ignition switch is in the ON position with the engine not running. Also, it should illuminate with an improperly operating charging circuit while the engine is running.

Engine Oil Pressure Light

The engine oil pressure light should come on when the ignition switch is in the ON position with the engine not running. Also, it should illuminate with the engine running if the engine oil pressure drops to an unsafe level.

IMPORTANT: If the oil pressure indicator light is illuminated with the engine running, shut off the engine immediately.

To test the oil pressure light and circuit wiring, ground the wire attached to oil pressure switch located on the engine near the oil filter. Turn ignition switch to the ON position; the engine oil pressure light should come on indicating correct operation of the indicator light and circuit wiring.

High Temperature Warning Light

If the engine coolant temperature reaches 221ºF (105ºC) (approximate), the high temperature warning light should come on.

To test the high temperature warning light and circuit wiring, turn ignition switch to the ON position and ground the gray wire attached to high temperature sender located on the engine water pump housing (see Temperature Sender in this Chapter). The high temperature warning light should illuminate.

Glow Plug Indicator Light

The glow plug light should come on when the ignition switch is placed in the ON position prior to placing the ignition switch in START. The light should stay lit for approximately 6 seconds while the ignition switch is left in the ON position.

Testing Indicator Lights

1. Apply 12 VDC to terminals 1A and 2A (Fig. 11).
2. Ground terminals 1B and 2B (Fig. 11).
3. Both indicator lights should illuminate.

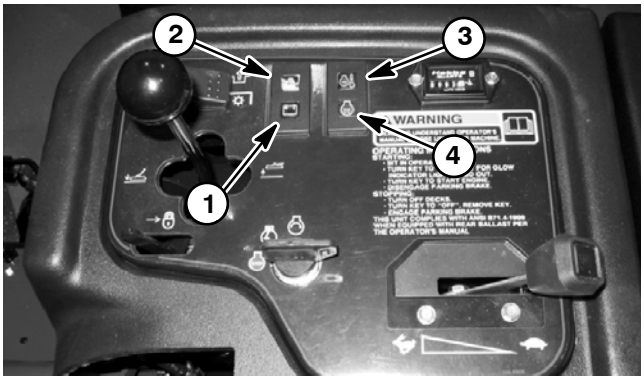

Figure 10

1. **Charge indicator**
2. **Engine oil pressure**
3. **High temp shutdown**
4. **Glow plug indicator**

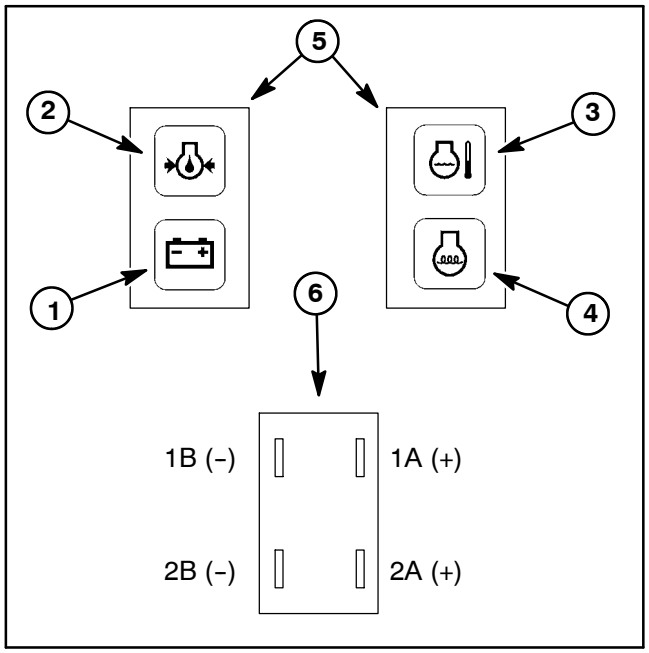

Figure 11

1. **Charge indicator**
2. **Engine oil pressure**
3. **High temperature**
4. **Glow plug indicator**
5. **Indicator light front**
6. **Indicator light back**

PTO Switch

The PTO switch is located on the control panel (Fig. 12). This rocker switch allows the decks to be engaged or disengaged. Along with additional switches in the interlock system, the PTO switch controls the solenoid valve on the hydraulic manifold.

The Standard Control Module monitors the operation of the PTO switch. If the ignition switch is in the ON position and the PTO switch is moved to engage, the Module PTO switch input LED should be illuminated.

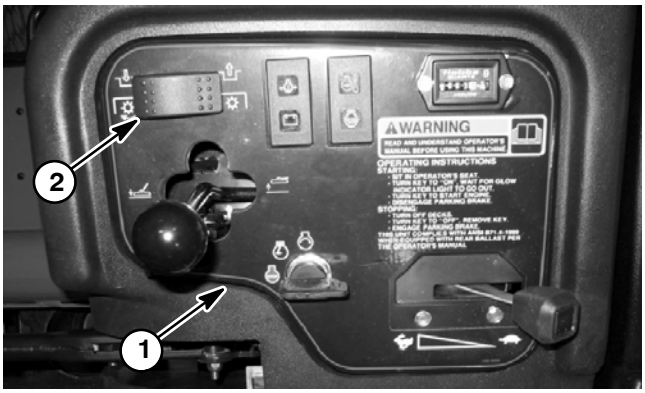

Figure 12

1. Control panel
2. PTO switch

Testing

The PTO switch terminals are marked as shown in Fig. 13. The circuitry of the PTO switch is shown in the chart below. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. Verify continuity between switch terminals.

SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
ENGAGE	5 + 6	2 + 3
DISENGAGE	1 + 2	4 + 5

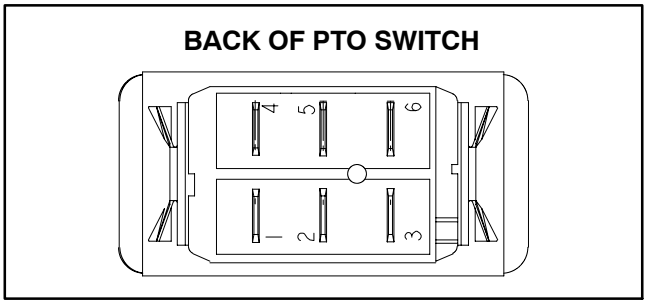

Figure 13

Diode Assembly

Diode D1 is used for circuit protection from inductive voltage spikes when the deck drive solenoid is de-energized. The diode plugs into the wiring harness under the control console.

Testing

The diode (Fig. 14) can be tested using a digital multimeter (diode test or ohms setting) and the table **below**.

Multimeter Red Lead (+) on Terminal	Multimeter Black Lead (-) on Terminal	Continuity
Female	Male	YES
Male	Female	NO

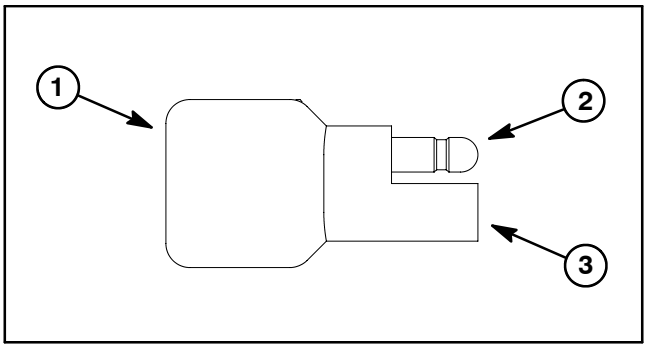

Figure 14

1. Diode
2. Male terminal
3. Female terminal

Neutral Switch

The neutral switch is a proximity type, normally open reed switch that closes when the traction pedal is in the neutral position. The neutral switch is located under the floor support plate (Fig. 15).

The Standard Control Module monitors the operation of the neutral switch. If the ignition switch is in the ON position and the traction pedal is in the neutral position, the Module Neutral input LED should be illuminated.

Testing

1. Make sure ignition switch is in the OFF position. Disconnect electrical connector from the neutral switch.

2. Check the continuity of the switch by connecting a multimeter (ohms setting) across the connector terminals.

3. With the traction pedal in the neutral position, there should be continuity between the two switch leads.

4. Slowly depress the traction pedal. The continuity tester should show no continuity as the pedal is moved in either the forward or reverse direction.

5. Reconnect switch after testing.

6. Switch adjustment: neutral switch should be installed so that the pin on the traction pedal (neutral position) is centered with the switch when the pedal is in the neutral position.

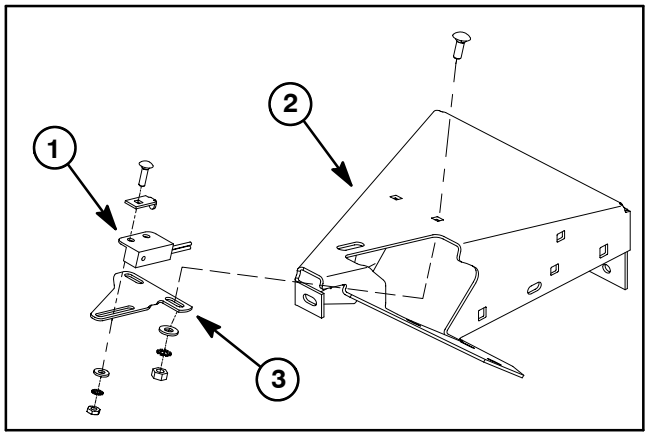

Figure 15

1. **Neutral switch**
2. **Floor support plate**
3. **Switch bracket**

Seat Switch

The seat switch is normally open and closes when the operator is on the seat. If the traction system or PTO switch is engaged when the operator raises out of the seat, the engine will stop. The seat switch (Fig. 16) and its electrical connector are located directly under the seat.

The Standard Control Module monitors the operation of the seat switch. If the ignition switch is in the ON position and the seat is occupied, the Module in seat input LED should be illuminated.

Testing

1. Make sure ignition switch is in the OFF position. Remove seat (see Operator Seat in Service and Repairs section of Chapter 6 – Chassis).

2. Disconnect electrical connector from the switch.

3. Check the continuity of the switch by connecting a multimeter (ohms setting) across the connector terminals.

4. With no pressure on the seat, there should be no continuity between the seat switch terminals.

5. Press directly onto the seat switch through the seat cushion. There should be continuity as the seat cushion approaches the bottom of its travel.

6. Reconnect seat switch connector. Reinstall seat assembly.

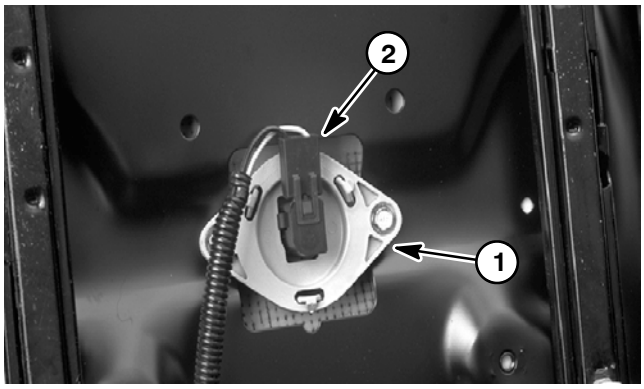

Figure 16

1. **Seat switch**
2. **Electrical connector**

Parking Brake and Transport/Mow Switches

The switches used for the parking brake and transport/mow are the same, normally closed switch.

The parking brake switch opens when the parking brake lever is engaged. The switch is located under the dash cover (Fig. 17).

The Standard Control Module monitors the operation of the parking brake switch. If the ignition switch is in the ON position and the parking brake is disengaged, the Module Parking Brake Off input LED should be illuminated.

The transport/mow switch opens when the transport/mow slide is in the transport position. The switch is located under the floor plate (Fig 18).

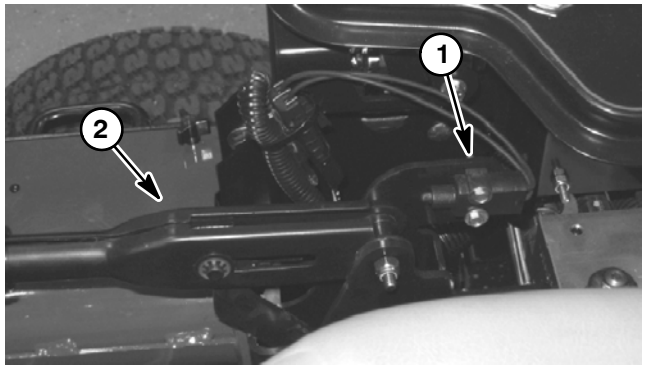

Figure 17

1. **Parking brake switch** 2. **Parking brake lever**

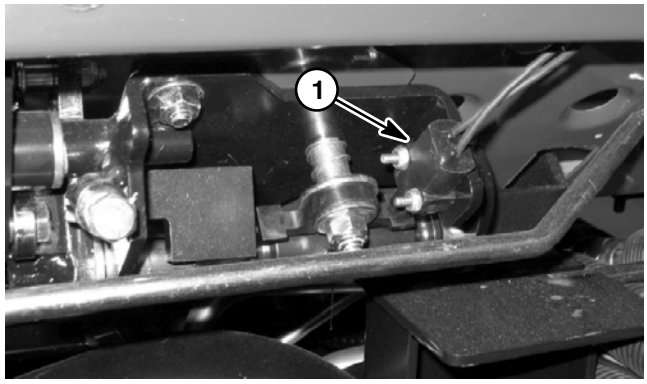

Figure 18

1. **Transport/Mow switch**

Testing

1. Make sure ignition switch is in the OFF position. Locate switch for testing.

2. Disconnect electrical connector from the switch.

3. Check the continuity of the switch by connecting a multimeter (ohms setting) across the connector terminals.

4. When the switch plunger is extended there should be continuity between the switch terminals.

5. When the switch plunger is depressed, there should be no continuity between the switch terminals.

6. Reconnect switch connector.

Fusible Link Harness

The Groundsmaster 3505–D uses three (3) fusible links for circuit protection. These fusible links are located in a harness that connects the starter B+ terminal to the main wire harness. If any of these links should fail, current to the protected circuit will cease. Refer to wire harness drawings in Chapter 8 – Electrical Diagrams for additional fusible link information.

Use a multimeter to make sure that continuity exists between each terminal pin in connector P1 and connector J1 at the starter (Fig. 19). If any of the fusible links are open, replace the complete harness.

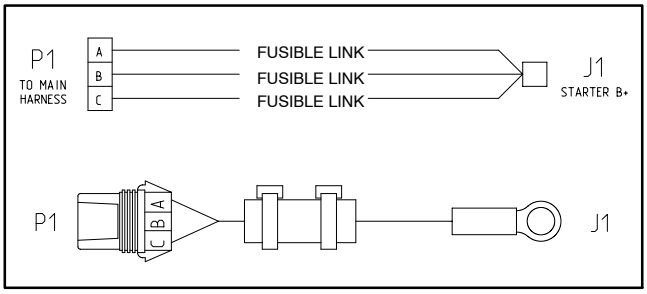

Figure 19

High Temperature Warning Switch

The high temperature warning switch is located on the water pump housing on the rear of the engine block (Fig. 20). The high temperature warning switch has a gray wire connected to it.

The Standard Control Module monitors the operation of the high temperature warning switch. If the ignition switch is in the ON position and the high temperature warning switch has closed due to excessive coolant temperature, the Module Over Temperature Warning input LED should be illuminated. The high temperature indicator light on the control panel should also illuminate.

If the cutting decks are engaged when the high temperature warning switch closes, the decks should shut off.

Testing

CAUTION

Make sure engine is cool before removing the temperature switch.

1. Make sure ignition switch is in the OFF position. Lower coolant level in the engine and remove the temperature switch.

2. Put switch in a container of oil with a thermometer and slowly heat the oil (Fig. 21).

CAUTION

Handle the hot oil with extreme care to prevent personal injury or fire.

3. Check continuity of the switch with a multimeter (ohms setting).

   A. The high temperature warning switch is normally open and should close between 216 to 226ºF (102 to 108ºC).

   B. The meter should indicate more than 600 ohms at 70ºF (21ºC).

   C. The meter should indicate approximately 460 ohms at 100ºF (38ºC).

   D. The meter should indicate from 54 to 78 ohms at 200ºF (93ºC).

4. Allow oil to cool while observing temperature. The high temperature warning switch should open at about 208ºF (98ºC).

5. Replace switch if specifications are not met.

6. Install switch to the engine housing.

   A. Clean threads of housing and switch thoroughly. Apply thread sealant to the threads of the switch.

   B. Thread switch into the housing. Torque switch from 16 to 20 ft-lb (21.7 to 27.1 N-m).

   C. Reconnect wire to switch.

7. Fill engine cooling system (see Traction Unit Operator's Manual).

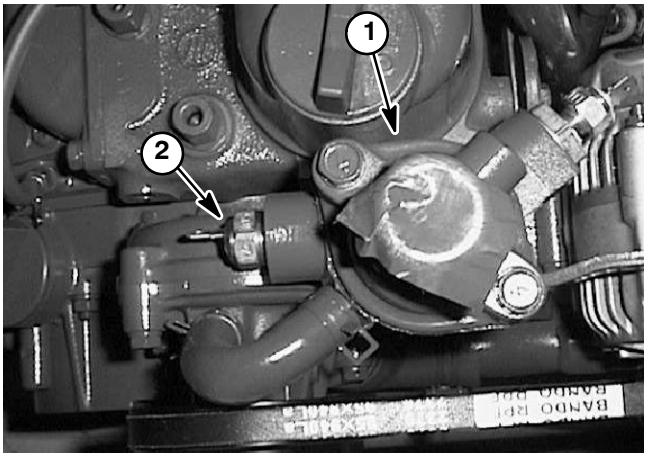

Figure 20

1. **Water pump housing** 2. **Warning switch**

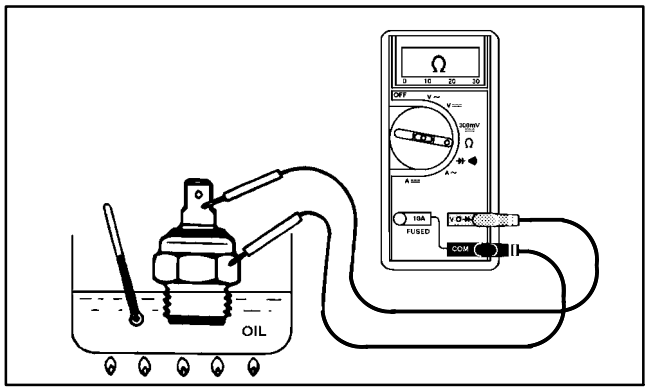

Figure 21

High Temperature Shutdown Switch

The high temperature shutdown switch is located on the water pump housing on the rear of the engine block (Fig. 20). The shutdown switch has a blue/white wire connected to it.

The Standard Control Module monitors the operation of the high temperature shutdown switch. If the ignition switch is in the ON position (engine running) and the high temperature shutdown switch closes due to excessive coolant temperature, the Module Over Temperature Shutdown input LED should illuminate and the engine should shut down.

Testing

CAUTION

Make sure engine is cool before removing the temperature switch.

1. Make sure ignition switch is in the OFF position. Lower coolant level in the engine and remove the temperature switch.

2. Put switch in a container of oil with a thermometer and slowly heat the oil (Fig. 21).

CAUTION

Handle the hot oil with extreme care to prevent personal injury or fire.

3. Check continuity of the switch with a multimeter (ohms setting). The high temperature shutdown switch is normally open and should close between 225 to 235ºF (107 to 113ºC).

4. Allow oil to cool while observing temperature. The high temperature shutdown switch should open at about 219ºF (104ºC).

5. Replace switch if specifications are not met.

6. Install switch to the engine housing.

   A. Clean threads of housing and switch thoroughly. Apply thread sealant to the threads of the switch.

   B. Thread switch into the housing. Torque switch from 16 to 20 ft-lb (21.7 to 27.1 N-m).

   C. Reconnect wire to switch.

7. Fill engine cooling system (see Traction Unit Operator's Manual).

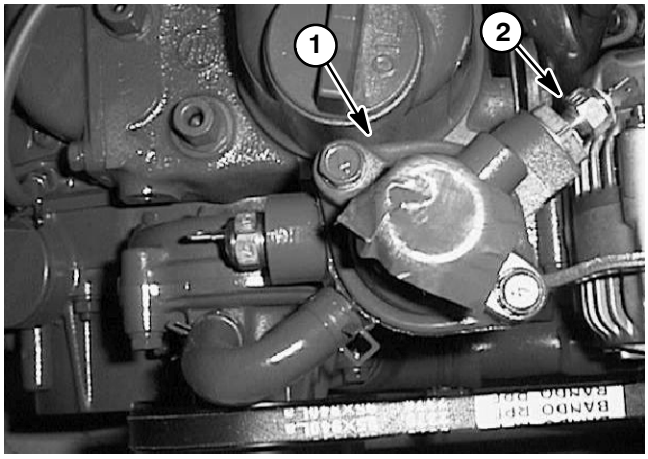

Figure 22

1. Water pump housing
2. Shutdown switch

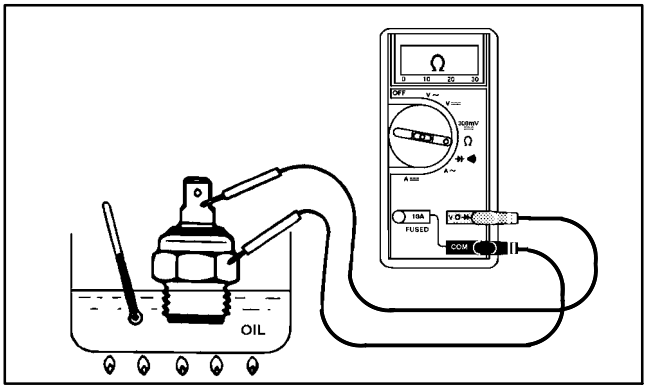

Figure 23

Fuel Pump

The fuel pump is attached to the frame just outboard of the fuel injection pump.

The Standard Control Module Run output LED will be illuminated when the fuel pump is energized.

Operational Test

1. Park machine on a level surface, lower cutting decks, stop engine and engage parking brake. Make sure ignition switch is in the OFF position. Unlatch and raise hood.

2. Disconnect electrical connector from the fuel stop solenoid to prevent the engine from firing.

3. Disconnect fuel hose (pump discharge) from the fuel filter.

4. Make sure fuel hoses attached to the fuel pump are free of obstructions.

5. Place fuel hose (pump discharge) into a large, graduated cylinder sufficient enough to collect 1 liter (33.8 fluid ounces).

IMPORTANT: When testing the fuel pump, DO NOT turn ignition switch to START.

6. Collect fuel in the graduated cylinder by turning ignition switch to the RUN position. Allow pump to run for time listed below, then return switch to OFF.

   A. For most Groundsmaster 3500−D machines, the amount of fuel collected in the graduated cylinder should be approximately **11.8 fl oz (350 ml) after thirty (30) seconds**.

   B. For machines that are equipped with a Biodiesel Conversion Kit, the amount of fuel collected in the graduated cylinder should be approximately **16 fl oz (475 ml) after fifteen (15) seconds**.

7. Replace fuel pump as necessary. Install fuel hose to the fuel filter.

8. Reconnect electrical connector to the fuel stop solenoid.

9. Bleed fuel system.

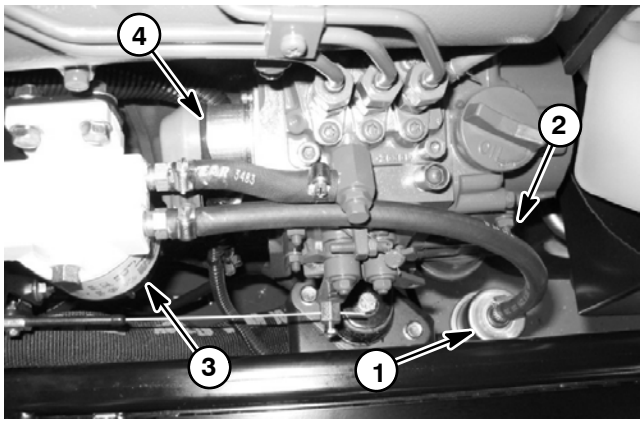

Figure 24

1. **Fuel pump**
2. **Fuel hose (discharge)**
3. **Fuel filter**
4. **Fuel stop solenoid**

Fuel Pump Specifications

Pump Capacity	23.5 fl oz/min (695 ml/min)
Pressure	3.3 psi (22.8 kPa)
Max. Current Draw	0.9 amp

Note: Fuel pump specifications for machines equipped with a Biodiesel Conversion Kit are as follows:

Pump Capacity	64 fl oz/min (1.9 liters/min)
Pressure	7 PSI (48.3 kPa)
Current Draw	2.0 amp

Fuel Stop Solenoid

The fuel stop solenoid used on the Groundsmaster 3505–D must be energized for the diesel engine to run. The solenoid is mounted to the injection pump on the engine (Fig. 25).

The fuel stop solenoid includes two coils for operation: the pull coil and the hold coil. When the ignition switch is turned to START, the fuel stop solenoid is initially energized and the pull coil retracts the solenoid plunger. Once the plunger is retracted, the hold coil will keep it retracted for continued engine operation. When the solenoid is de–energized, the plunger extends to shut off fuel supply to the engine causing the engine to stop running. The fuel stop solenoid is grounded through the solenoid housing.

The Standard Control Module Run output LED will be illuminated when the fuel stop solenoid is energized.

NOTE: Refer to Chapter 8 – Electrical Diagrams when troubleshooting the fuel stop solenoid.

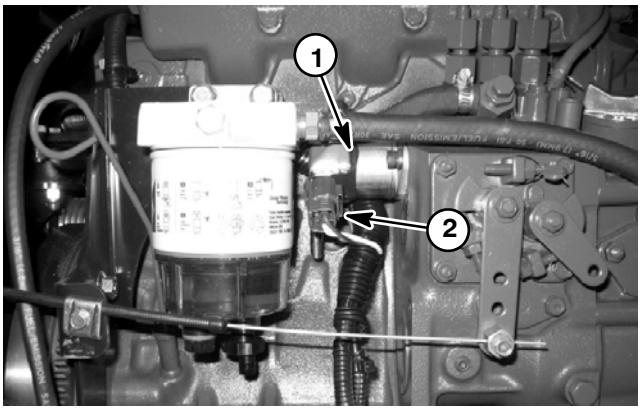

Figure 25

1. **Fuel stop solenoid**
2. **Harness connector**

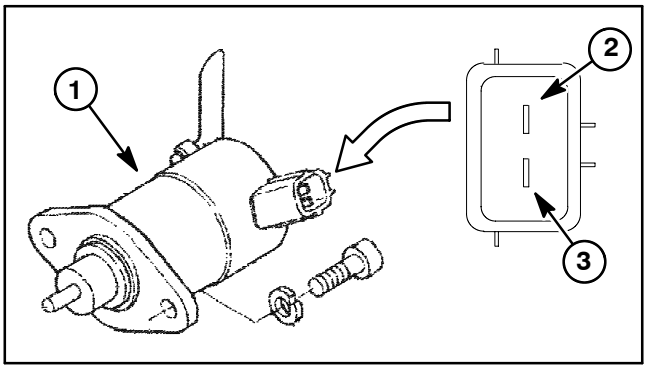

Figure 26

1. **Fuel stop solenoid**
2. **Pull coil terminal**
3. **Hold coil terminal**

In Place Testing

NOTE: Prior to taking small resistance readings with a digital multimeter, short the test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value of the component you are testing.

1. Make sure ignition switch is in the OFF position. Disconnect wire harness connector from fuel stop solenoid.

2. Using a digital multimeter, touch one test lead to the pull coil terminal and the other test lead to the fuel stop solenoid frame (ground) (Fig. 26). The resistance of the pull coil should be less than 1 ohm (but not zero).

3. Using a digital multimeter, touch one test lead to the hold coil terminal and the other test lead to the fuel stop solenoid frame (ground) (Fig. 26). The resistance of the hold coil should be approximately 15 ohms.

4. Connect solenoid to the wiring harness.

Glow Controller

The controller is located under the right, lower corner of the instrument panel.

NOTE: Refer to Chapter 8 – Electrical Diagrams when troubleshooting the glow controller.

Controller Operation

1. When the ignition switch is placed in the RUN position, the controller energizes the glow plugs and lights up the glow lamp for 10 seconds.

2. When the ignition switch is held in the START position, the glow plugs will energize while the switch is held in START and the glow lamp will **not** light.

3. When the ignition switch is released from START to RUN, the glow plugs will de–energize and the glow lamp will remain off.

Controller Checks

1. Make sure there is power from the battery.

2. Disconnect electrical connector to the fuel stop solenoid to prevent the engine from starting.

3. Place ignition switch in the RUN position. Verify the following while in the RUN position:

   A. Glow indicator lamp is on.

   B. Glow relay is energized.

   C. Glow plugs are energized.

   D. Glow indicator lamp goes out and glow plugs de–energize after 10 seconds.

4. Place ignition switch in the START position. Verify the following while in the START position:

   A. Glow indicator lamp is out.

   B. Glow relay is energized.

   C. Glow plugs are energized.

   D. Power exists at terminal 1 of the glow controller.

NOTE: If there is no power to terminal 1 of the glow controller, verify continuity of the circuitry from the ignition switch to the controller and perform Step 4 again (see Chapter 8 – Electrical Diagrams).

5. If any of the conditions in Step 3 are not met or power to terminal 1 exists and any of the other conditions in Step 4 are not met:

   A. Verify continuity of the circuitry from the battery to the glow relay and glow plugs (see Chapter 8 – Electrical Diagrams).

   B. Verify continuity of the circuitry from the battery to ignition switch, glow controller, glow lamp, glow relay and ground (see Chapter 8 – Electrical Diagrams).

   C. Replace parts as necessary.

6. Connect electrical connector to the fuel stop solenoid.

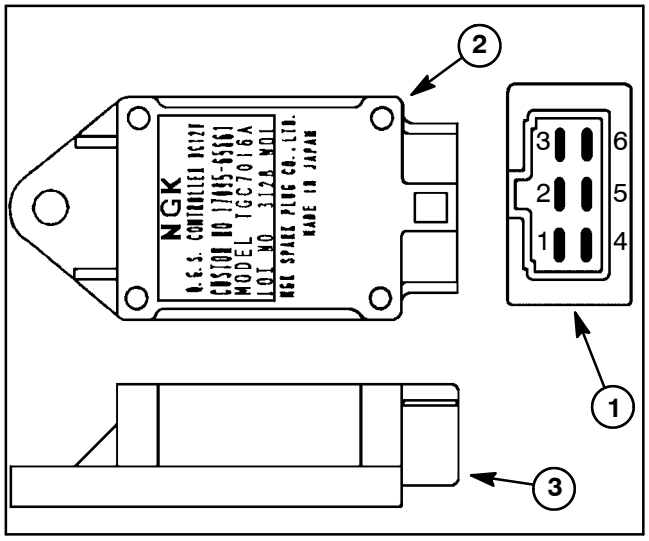

Figure 27

1. **Glow controller end view**
2. **Top view**
3. **Side view**

Standard Control Module

The Groundsmaster 3505–D is equipped with a Standard Control Module to monitor and control electrical components required for safe operation. This Module is attached to the back of the instrument panel (Fig. 28).

Inputs from the ignition, neutral, parking brake, PTO and high temperature switches are monitored by the Module. Current output to the electric starter motor, fuel pump, engine run solenoid and PTO (deck drive solenoid) are controlled based on the inputs received by the Module.

The Standard Control Module does not connect to an external computer or hand held device, can not be re–programmed and does not record intermittent fault data.

The Standard Control Module can be used to check operation of machine switches by monitoring the LED of the module. If a Module LED does not illuminate (e.g. the in seat input LED does not illuminate with the seat occupied and the ignition switch in the run position), testing of the switch and circuit wiring would be required.

Refer to the Traction Unit Operator's Manual for additional Standard Control Module information.

Control Module Inputs (Fig. 29)

The Power input LED should be illuminated when the ignition key switch is in the RUN or START position.

The Start input LED should be illuminated when the ignition key switch is in the START position.

The Neutral input LED should be illuminated when the traction pedal is in the neutral position.

The Parking Brake Off input LED should be illuminated when the parking brake is not engaged.

The PTO Switch input LED should be illuminated when the PTO switch is engaged.

The In Seat input LED should be illuminated when the operator is sitting in the seat.

The Over Temperature Shutdown input LED should be illuminated when excessive engine coolant temperature causes the high temperature shutdown switch to close.

The Backlap input LED is not used on the Groundsmaster 3505–D.

Control Module Outputs (Fig. 29)

The Start output LED should be illuminated when the ignition key switch is in the START position with the traction pedal in neutral, the PTO switch off and either the seat occupied or parking brake engaged.

The Run output LED should be illuminated when the ignition key switch is in the ON position and inputs from the neutral, parking brake, PTO, seat and over temperature switches indicate safe engine operation (e.g. seat occupied and parking brake disengaged when traction pedal is depressed).

The PTO output LED should be illuminated when the ignition key switch is in the ON position and the PTO switch is pulled out. Note: If Module Over Temperature Warning input LED is illuminated, PTO output LED will not be illuminated and PTO will not be engaged regardless of PTO switch position.

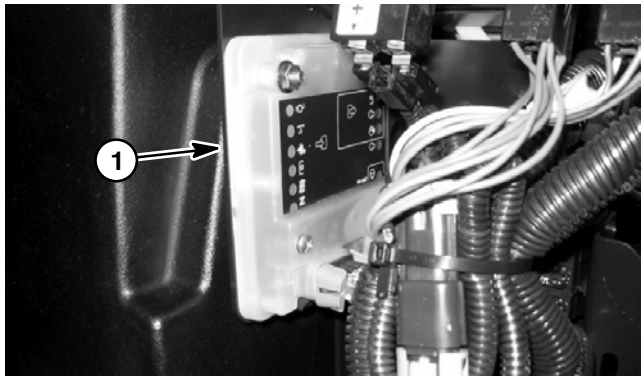

Figure 28

1. **Standard Control Module**

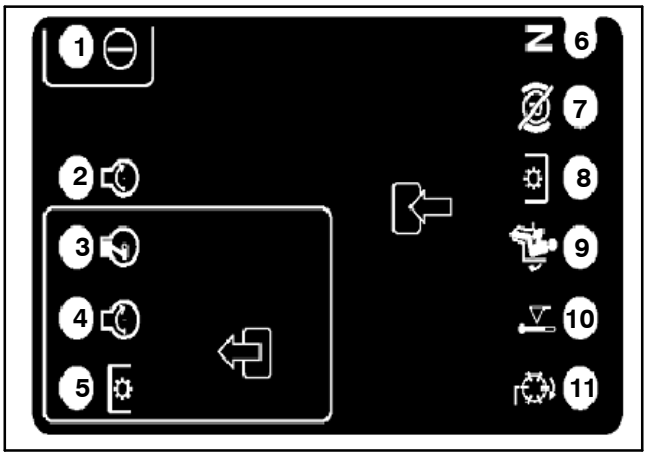

Figure 29

1. **Power input LED**
2. **Start input LED**
3. **Engine run output LED**
4. **Start output LED**
5. **PTO output LED**
6. **Neutral input LED**
7. **Park brake off input LED**
8. **PTO switch input LED**
9. **In seat input LED**
10. **High temp input LED**
11. **Backlap input (not used)**

Service and Repairs

NOTE: For more electrical component repair information, see the Kubota Workshop Manual, Diesel Engine, 05 Series.

Battery Storage

If the machine will be stored for more than 30 days:

1. Make sure ignition switch is in the OFF position. Remove the battery and charge it fully (see Battery Service).

2. Either store battery on a shelf or on the machine.

3. Leave cables disconnected if the battery is stored on the machine.

4. Store battery in a cool atmosphere to avoid quick deterioration of the battery charge.

5. To help prevent the battery from freezing, make sure it is fully charged (see Battery Service).

Battery Care

1. Battery electrolyte level must be properly maintained. The top of the battery must be kept clean. If the machine is stored in a location where temperatures are extremely high, the battery will discharge more rapidly than if the machine is stored in a location where temperatures are cool.

WARNING

Wear safety goggles and rubber gloves when working with electrolyte. Charge battery in a well ventilated place so gasses produced while charging can dissipate. Since the gases are explosive, keep open flames and electrical sparks away from the battery; do not smoke. Nausea may result if the gases are inhaled. Unplug charger from electrical outlet before connecting or disconnecting charger leads to or from battery posts.

2. Keep top of battery clean by washing periodically with a brush dipped in ammonia or bicarbonate of soda solution. Flush top surface with water after cleaning. Do not remove the fill caps while cleaning.

3. Battery cables must be tight on terminals to provide good electrical contact.

WARNING

Connecting cables to the wrong post could result in personal injury and/or damage to the electrical system.

4. If corrosion occurs at terminals, disconnect cables. Always disconnect negative (-) cable first. Scrape clamps and terminals separately. Reconnect cables with positive (+) cable first. Coat terminals with battery terminal protector (Toro Part No. 107-0392) or a light coat of grease to reduce corrosion after connections are made.

5. Check electrolyte level every 25 operating hours and every 30 days if machine is in storage.

6. Maintain cell level with distilled or demineralized water. Do not fill cells above the fill line.

Battery Service

The battery is the heart of the electrical system. With regular and proper service, battery life can be extended. Additionally, battery and electrical component failure can be prevented.

CAUTION

When working with batteries, use extreme caution to avoid splashing or spilling electrolyte. Electrolyte can destroy clothing and burn skin or eyes. Always wear safety goggles and a face shield when working with batteries.

Electrolyte Specific Gravity
Fully charged: 1.265 corrected to 80ºF (26.7ºC)
Discharged: less than 1.240

Battery Specifications
BCI Group Size 55:
585 CCA at 0º F (-17.8º C)
Reserve Capacity of 95 minutes at 80ºF (26.7ºC)

Dimensions (including terminal posts and caps)

Length	9.05 inches (22.99 cm)
Width	6.03 inches (15.31 cm)
Height	8.50 inches (21.58 cm)

Removal (Fig. 30 and 31)

IMPORTANT: Be careful not to damage terminal posts or cable connectors when removing the battery cables.

1. Remove battery cover from the frame. Loosen battery retainer securing the back of the battery to the battery support.

2. Loosen nut on ground cable (–) first and remove ground cable from battery. This should prevent short circuiting the battery, other components or the operators hands.

3. Loosen nut on positive cable (+) and remove positive cable from battery.

4. Make sure battery vent caps are on tightly.

5. Remove battery from the battery compartment to a service area to allow better access for service.

Inspection, Maintenance and Testing

1. Perform the following inspections and maintenance:

   A. Check for cracks. Replace battery if cracked or leaking.

   B. Check battery terminal posts for corrosion. Use wire brush to clean corrosion from posts.

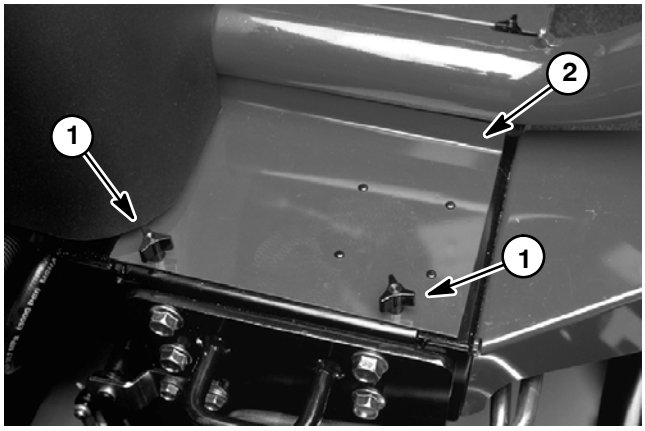

Figure 30

1. Knob
2. Battery cover

Figure 31

1. Ground cable
2. Positive cable

IMPORTANT: Before cleaning the battery, tape or block vent holes to the filler caps and make sure the caps are on tightly.

   C. Check for signs of wetness or leakage on the top of the battery which might indicate a loose or missing filler cap, overcharging, loose terminal post or overfilling. Also, check battery case for dirt and oil. Clean the battery with a solution of baking soda and water, then rinse it with clean water.

   D. Check that the cover seal is not broken away. Replace the battery if the seal is broken or leaking.

   E. Check the electrolyte level in each cell. If the level is below the tops of the plates in any cell, fill all cells with **distilled** water between the minimum and maximum fill lines. Charge at 15 to 25 amps for 15 minutes to allow sufficient mixing of the electrolyte.

2. Conduct a hydrometer test of the battery electrolyte.

IMPORTANT: Make sure the area around the cells is clean before opening the battery caps.

A. Measure the specific gravity of each cell with a hydrometer. Draw electrolyte in and out of the hydrometer barrel prior to taking a reading to warm–up the hydrometer. At the same time, take the temperature of the cell.

B. Temperature correct each cell reading. For each 10°F (5.5°C) above 80°F (26.7°C) add 0.004 to the specific gravity reading. For each 10°F (5.5°C) below 80°F (26.7°C) subtract 0.004 from the specific gravity reading.

Example: Cell Temperature 100°F
Cell Gravity 1.245
100°F minus 80°F equals 20°F
(37.7°C minus 26.7°C equals 11.0°C)
20°F multiply by 0.004/10°F equals 0.008
(11°C multiply by 0.004/5.5°C equals 0.008)
ADD (conversion above) 0.008
Correction to 80°F (26.7°C) 1.253

C. If the difference between the highest and lowest cell specific gravity is 0.050 or greater or the lowest cell specific gravity is less than 1.225, charge the battery. Charge at the recommended rate and time given in **Charging** or until all cells specific gravity is 1.225 or greater with the difference in specific gravity between the highest and lowest cell less than 0.050. If these charging conditions can not be met, replace the battery.

3. Perform a high–discharge test with an adjustable load tester.

This is one of the most reliable means of testing a battery as it simulates the cold–cranking test. A commercial battery load tester is **required** to perform this test.

CAUTION

Follow the manufacturer's instructions when using a battery tester.

A. Check the voltage across the battery terminals prior to testing the battery. If the voltage is less than 12.4 VDC, recharge the battery.

B. If the battery has been charged, apply a 150 amp load for 15 seconds to remove the surface charge. Use a battery load tester following the manufacturer's instructions.

C. Make sure battery terminals are free of corrosion.

D. Measure the temperature of the center cell.

E. Connect a battery load tester to the battery terminals **following the manufacturer's instructions**. Connect a digital multimeter to the battery terminals.

F. Apply a test load of one half the Cranking Performance (see Battery Specifications) rating of the battery for 15 seconds.

G. Take a voltage reading at 15 seconds, then remove the load.

H. Using the table below, determine the minimum voltage for the cell temperature reading.

Minimum Voltage	Battery Electrolyte Temperature	
9.6	70°F (and up)	21.1°C (and up)
9.5	60°F	15.6°C
9.4	50°F	10.0°C
9.3	40°F	4.4°C
9.1	30°F	–1.1°C
8.9	20°F	–6.7°C
8.7	10°F	–12.2°C
8.5	0°F	–17.8°C

I. If the test voltage is below the minimum, replace the battery. If the test voltage is at or above the minimum, return the battery to service.

Installation

IMPORTANT: To prevent possible electrical problems, install only a fully charged battery.

1. Make sure ignition and all accessories are OFF.

2. Make sure battery compartment is clean and repainted if necessary.

3. Make sure all battery cables, battery retainer and electrical connections are in good condition.

4. Place battery in its compartment. Make sure battery is level and flat. Connect positive (+) cable connector onto positive (+) battery post. Tighten cap screw and lock nut with two wrenches.

IMPORTANT: The nut and flat washer must be on top of the battery retainer during installation to prevent the cap screw from hitting hydraulic hard lines when the sidewinder is shifted.

5. Secure battery retainer. Do not overtighten to prevent cracking or distorting the battery case.

6. Connect a digital multimeter (set to amps) between the negative (–) battery post and the negative (–) (ground) cable connector. The reading should be less than 0.1 amp. If the reading is 0.1 amp or more, the unit's electrical system should be tested and repaired.

7. Connect negative (–) (ground) cable connector to the negative (–) battery post. Tighten cap screw and lock nut with two wrenches.

8. Apply battery terminal protector (Toro Part No. 107–0392) or a light coat of grease on all battery posts and cable connectors to reduce corrosion after connections are made.

Charging

To minimize possible damage to the battery and allow the battery to be fully charged, the slow charging method is presented here. This charging method can be accomplished with a constant current battery charger which is available in most shops.

CAUTION

Follow the manufacturer's instructions when using a battery charger.

NOTE: Using specific gravity of the battery cells is the most accurate method of determining battery condition.

1. Determine the battery charge level from either its specific gravity or open circuit voltage.

Battery Charge Level	Specific Gravity	Open Circuit Voltage
100%	1.265	12.68
75%	1.225	12.45
50%	1.190	12.24
25%	1.155	12.06
0%	1.120	11.89

2. Determine the charging time and rate **using the manufacturer's battery charger instructions** or the following table:

Battery Reserve Capacity (Minutes)	Battery Charge Level (Percent of Fully Charged)			
	75%	50%	25%	0%
80 or less	3.8 hrs @ 3 amps	7.5 hrs @ 3 amps	11.3 hrs @ 3 amps	15 hrs @ 3 amps
81 to 125	5.3 hrs @ 4 amps	10.5 hrs @ 4 amps	15.8 hrs @ 4 amps	21 hrs @ 4 amps
126 to 170	5.5 hrs @ 5 amps	11 hrs @ 5 amps	16.5 hrs @ 5 amps	22 hrs @ 5 amps
171 to 250	5.8 hrs @ 6 amps	11.5 hrs @ 6 amps	17.3 hrs @ 6 amps	23 hrs @ 6 amps
above 250	6 hrs @ 10 amps	12 hrs @ 10 amps	18 hrs @ 10 amps	24 hrs @ 10 amps

CAUTION

Do not charge a frozen battery because it can explode and cause injury. Let the battery warm to 60°F (15.5° C) before connecting to a charger.

Charge the battery in a well–ventilated place to dissipate gases produced from charging. These gases are explosive; keep open flame and electrical spark away from the battery. Do not smoke. Nausea may result if the gases are inhaled. Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery posts.

3. **Following the manufacturer's instructions**, connect the charger cables to the battery. Make sure a good connection is made.

4. Charge the battery **following the manufacturer's instructions**.

5. Occasionally check the temperature of the battery electrolyte. If the temperature exceeds 125°F (51.6°C) or the electrolyte is violently gassing or spewing, the charging rate must be lowered or temporarily stopped.

6. Three hours prior to the end of the charging, measure the specific gravity of a battery cell once per hour. The battery is fully charged when the cells are gassing freely at a low charging rate and there is less than a 0.003 change in specific gravity for three consecutive readings.

Solenoid Valve Coil

The solenoid valve coil on the hydraulic control manifold (Fig. 32) can be replaced without opening the hydraulic system.

Removal

1. Park machine on a level surface, lower cutting decks, engage parking brake, stop engine and remove key from the ignition switch.

2. Disconnect the wire harness electrical connector from the solenoid valve coil.

3. Remove the nut from the spool assembly.

4. Slide the coil assembly from the solenoid valve stem. Discard the coil.

5. Clean any corrosion or dirt from the valve stem.

Installation

1. Slide new coil assembly onto the solenoid valve stem.

2. Install the nut onto the spool assembly and torque nut 60 in-lb (6.8 N-m) (do not over tighten).

3. Connect the wire harness electrical connector to the solenoid valve coil.

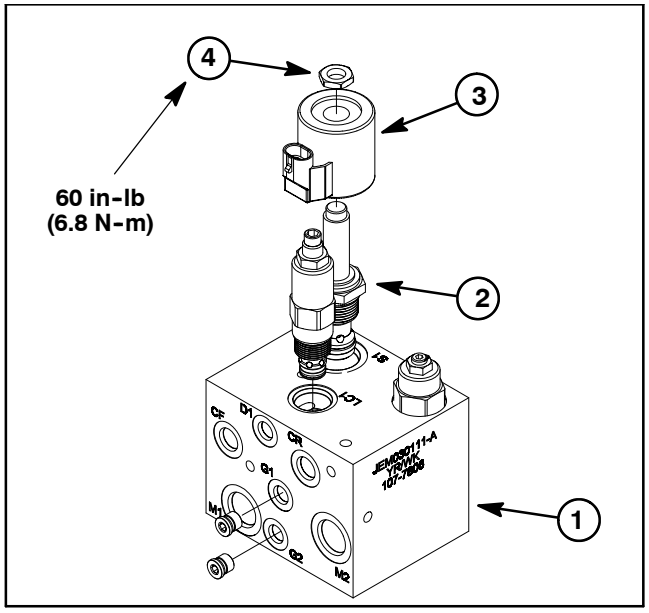

Figure 32

1. **Hydraulic manifold**
2. **Solenoid valve (R1)**
3. **Solenoid valve coil**
4. **Nut**

Chapter 6

Chassis

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Specifications

Item	Description
Tire pressure	14 to 18 PSI (0.97 to 1.24 bar)
Wheel lug nut torque	45 to 65 ft-lb (61 to 88 N-m)

Special Tools

Order special tools from your Toro Distributor.

Wheel Hub Puller

Part Number: **TOR4097**

The wheel hub puller allows safe removal of the wheel hub from the shaft of wheel motors.

Figure 1

Adjustments

Adjust Brakes

CAUTION

Before and after adjusting the brakes, always check the brakes in a wide open area that is flat and free of other persons and obstructions.

1. Check brake adjustment as follows:

   A. Park machine on a level surface, lower cutting units, stop engine and remove key from the ignition switch.

   B. Rotate by-pass valve on the piston pump 90 degrees to allow front wheels to turn freely (Fig. 2).

CAUTION

Before jacking up the machine, review and follow Jacking Instructions in Chapter 1 - Safety.

   C. Chock rear wheel. Jack up both front wheels and support the machine with jackstands or hardwood blocks.

   D. Apply the parking brake. The force to actuate the brake lever should be from 30 to 40 lbs (133 to 178 N).

   E. With the parking brake applied, use a torque wrench on the wheel hub lock nut to identify the break away torque at each front wheel. The minimum break away torque with the parking applied should be 300 ft-lb (407 N-m).

2. If adjustment is necessary, adjust brakes as follows:

   A. Remove both front wheel assemblies from the machine (see Front Brake and Wheel Removal in the Service and Repairs section).

   B. Adjust brakes by turning clevis to increase or decrease shoe pressure on the brake drum (Fig. 3). Make sure that brake shoes do not drag against drums with the parking brake lever released.

   C. If brakes can not be adjusted properly, repair or replace brake components as necessary.

   D. After adjustment is complete, install both front wheel assemblies to the machine (see Front Brake and Wheel Installation in the Service and Repairs section).

   E. Lower front wheels to the ground.

   F. Before starting engine, close by-pass valve on pump by rotating it 90 degrees (Fig. 2).

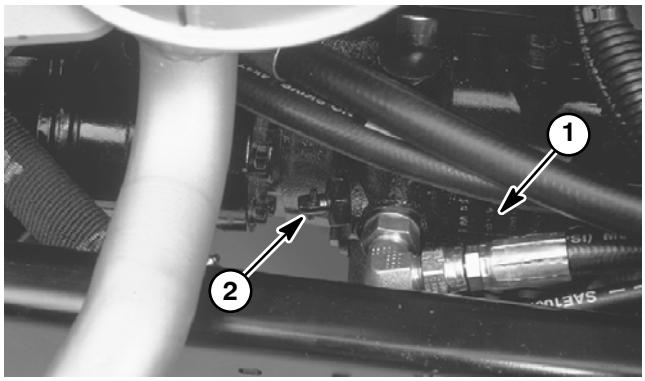

Figure 2

1. **Piston pump**
2. **By-pass valve**

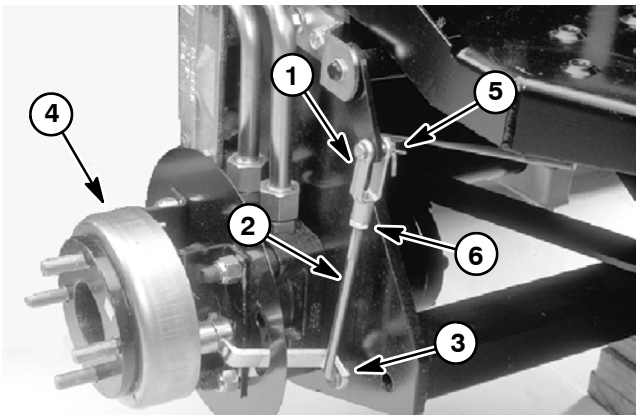

Figure 3

1. **Clevis**
2. **Adjustment rod**
3. **Brake lever**
4. **Wheel hub**
5. **Cotter pin**
6. **Jam nut**

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Operator Seat

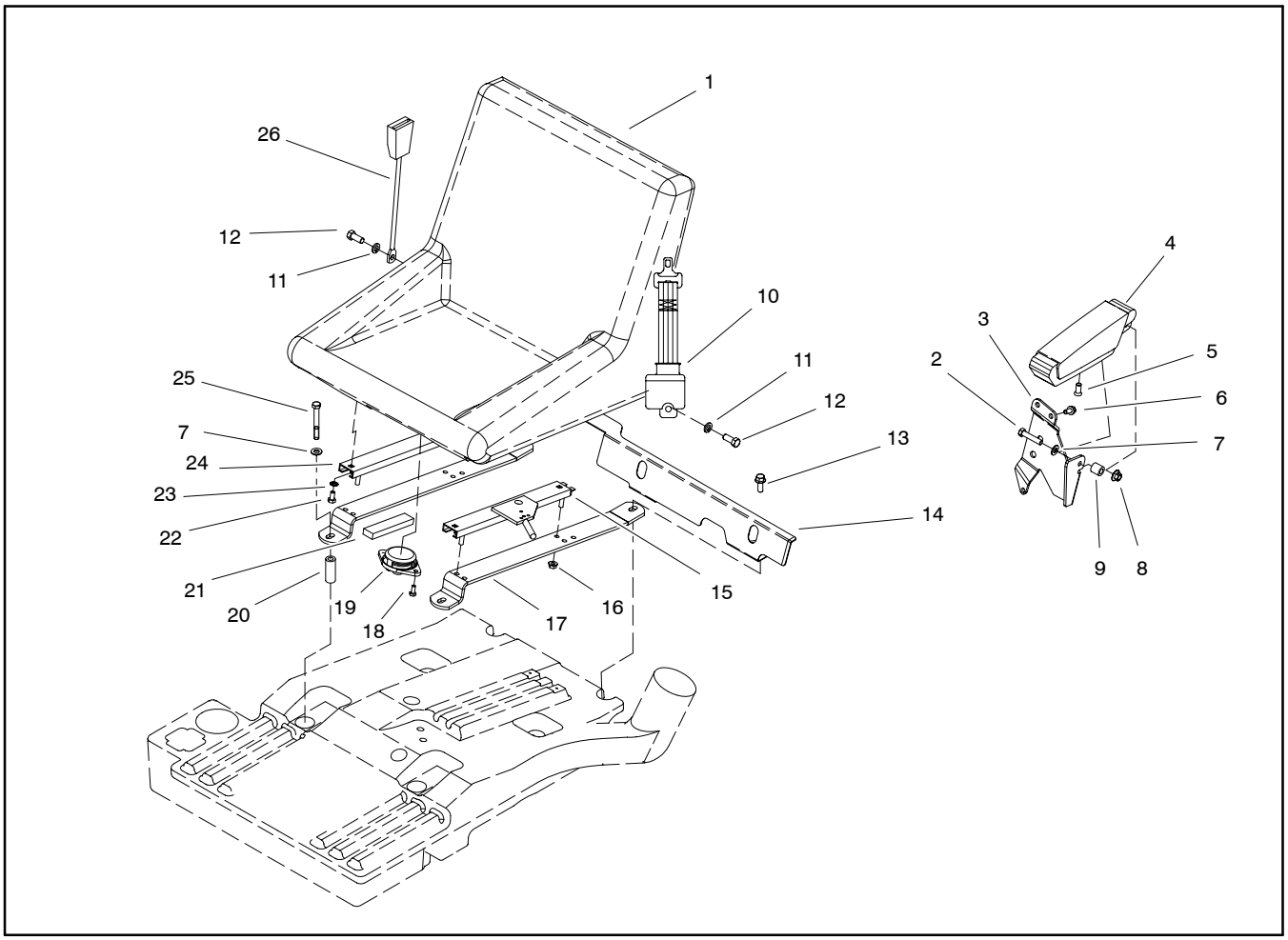

Figure 4

1. Seat
2. Cap screw
3. Armrest bracket (LH shown)
4. Armrest
5. Screw
6. Flange head screw (3 used per side)
7. Flat washer
8. Flange nut
9. Spacer
10. Seat belt
11. Lock washer
12. Cap screw
13. Flange head screw (2 used)
14. Heat shield
15. Seat adjuster with latch
16. Flange nut (2 used per seat adjuster)
17. Seat support strap (2 used)
18. Washer head screw (2 used)
19. Seat switch
20. Spacer (2 used)
21. Foam (2 used)
22. Cap screw (4 used)
23. Lock washer (4 used)
24. Seat adjuster
25. Cap screw (2 used)
26. Seat belt latch

Removal (Fig. 4)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. Remove two (2) flange head screws (item 13) and two (2) cap screws (item 25) with flat washers (item 7) that secure the seat support straps to the frame. Note location of spacers under front of seat support straps.

3. Disconnect wire harness electrical connector from the seat switch. Separate seat from the frame.

4. Remove seat parts as necessary to make repairs using Figure 4 as a guide.

Installation (Fig. 4)

1. Install any new seat parts using Figure 4 as a guide.

2. Position seat, spacers and support straps to the fuel tank and frame.

3. Connect wire harness electrical connector to the seat switch.

4. Secure seat support straps to the machine with two (2) flange head screws (item 13) and two (2) cap screws (item 25) with flat washers (item 7).

Front Wheels and Brakes

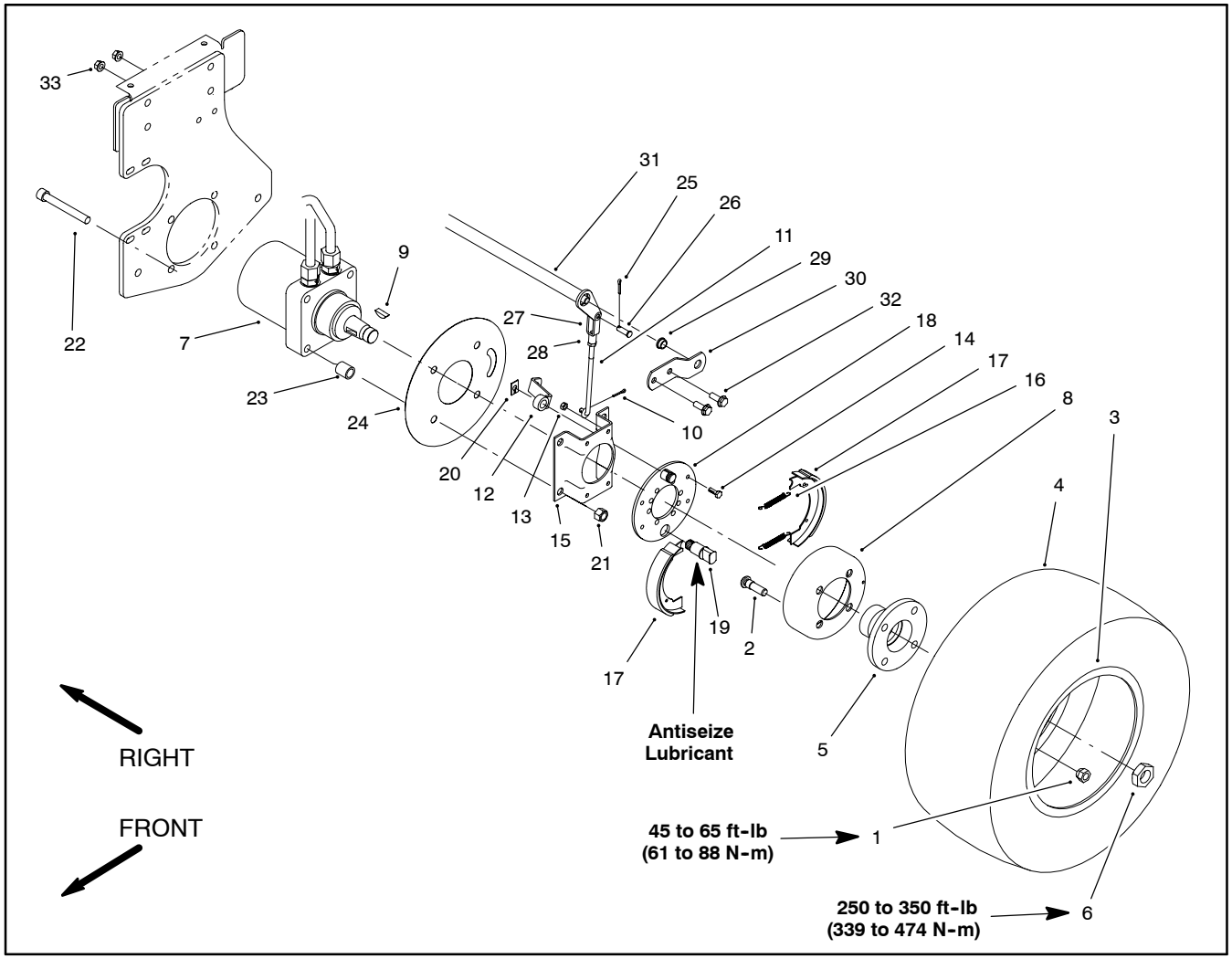

Figure 5

1. **Lug nut (4 used per wheel)**
2. **Drive stud (4 used per wheel)**
3. **Wheel rim**
4. **Tire**
5. **Wheel hub**
6. **Lock nut**
7. **Hydraulic wheel motor**
8. **Brake drum**
9. **Woodruff key**
10. **Cotter pin**
11. **Adjustment rod**
12. **Brake lever**
13. **Lock nut (4 used per wheel)**
14. **Cap screw (4 used per wheel)**
15. **Brake bracket**
16. **Return spring (2 used per wheel)**
17. **Brake shoe (2 used per wheel)**
18. **Backing plate**
19. **Cam shaft**
20. **Retainer clip**
21. **Lock nut (4 used per wheel)**
22. **Socket head screw (4 used per wheel)**
23. **Spacer (4 used per wheel)**
24. **Wheel shield**
25. **Cotter pin**
26. **Clevis pin**
27. **Clevis**
28. **Jam nut**
29. **Flange bushing**
30. **Brake pivot bracket**
31. **Brake pivot shaft**
32. **Flange head screw (2 per wheel)**
33. **Flange nut (2 per wheel)**

Removal (Fig. 5)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

WARNING

Before jacking up the machine, review and follow Jacking Instructions in Chapter 1 - Safety.

2. Jack up front wheel and use jack stands or blocking to keep the front tire off the floor.

3. Remove lug nuts from drive studs. Pull wheel from drive studs and wheel hub.

NOTE: The installation torque of the lock nut is from 250 to 350 ft-lb (339 to 474 N-m). Use impact wrench to remove lock nut from the hydraulic motor shaft.

4. Remove lock nut from the hydraulic motor shaft. Release parking brake.

IMPORTANT: Do not hit wheel hub or puller with a hammer during removal or installation. Hammering may cause damage to the hydraulic wheel motor.

5. Use wheel hub puller to remove wheel hub and brake drum from the hydraulic motor shaft (see Special Tools in this chapter). Remove woodruff key from the shaft.

6. Remove cotter pin that retains adjustment rod to brake lever. Separate adjustment rod from brake lever.

NOTE: The brake lever, backing plate, retainer clip, return springs, brake shoes and cam shaft can be removed as a complete brake assembly.

7. If it is desired to remove the brake assembly from the brake bracket, remove four cap screws and lock nuts securing the assembly to the bracket.

8. Disassemble brake assembly as follows (Fig. 6):

A. Remove return springs from the brake shoes. Remove brake shoes from the backing plate.

B. Matchmark brake cam and brake lever to assure proper alignment during assembly. Remove retaining clip from the brake cam. Pull brake lever from the cam. Remove cam from backing plate.

9. The brake bracket and wheel shield can be removed as follows:

A. Remove lock nuts, spacers and socket head screws securing the brake bracket, wheel shield and hydraulic motor to the frame.

B. Separate bracket and shield from the frame.

Installation (Fig. 5)

1. If removed, insert four socket head screws through the frame, hydraulic motor, spacers, wheel shield and brake bracket. Secure with lock nuts, but do not fully tighten.

2. Assemble brake assembly as follows (Fig. 6):

A. If removed, secure backing plate to the brake bracket with four cap screws and lock washers.

B. Apply antiseize lubricant to cam shaft splines. Insert cam shaft through the backing plate.

C. Attach brake lever to the cam shaft. Make sure matchmarks are aligned properly. Secure lever to shaft with retainer clip.

D. Lubricate brake shoe pivot points with a light coating of grease. Position both brake shoes on the backing plate so that the concave heels attach to the anchor pin.

E. Insert both return springs into the holes of both brake shoes. Make sure shoes fit snuggly against the anchor pin and cam shaft.

3. If the complete brake assembly was removed, secure brake assembly to the brake bracket with four cap screws and lock nuts. Tighten fasteners.

4. Attach adjustment rod to the brake lever and secure with cotter pin.

5. Make sure that wheel hub and hydraulic motor shafts are thoroughly clean. Install key to the slot on the hydraulic motor shaft. Slide wheel hub and brake drum assembly onto the shaft.

6. Secure wheel hub and brake drum to the hydraulic motor shaft with lock nut.

NOTE: For proper brake operation, the brake shoes and backing plate must be concentrically aligned with the brake drum.

7. To align brake shoes and drum, apply parking brake. Then tighten four socket head screws and lock nuts that secure the brake bracket and wheel motor to the frame.

8. Secure wheel to machine with four (4) lug nuts.

9. Lower wheel to ground. Torque wheel lug nuts from 45 to 65 ft-lb (61 to 88 N-m) in a crossing pattern.

10. Torque lock nut (item 6) from 250 to 350 ft-lb (339 to 474 N-m). Release parking brake.

11. Check brake adjustment and and adjust if necessary (see Adjust Brakes in the Adjustments section).

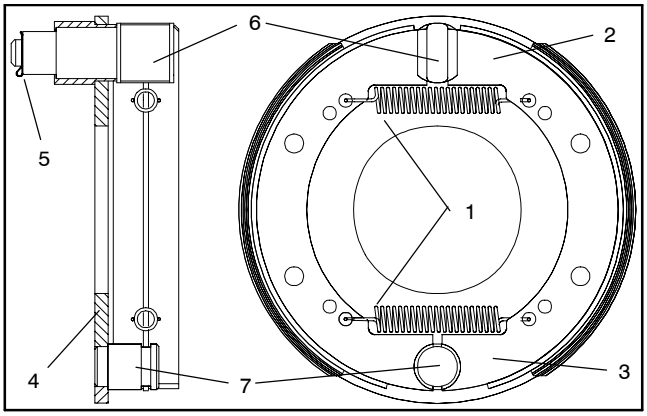

Figure 6

1. **Return spring**
2. **Brake shoe (toe end)**
3. **Brake shoe (heel end)**
4. **Backing plate**
5. **Retaining clip**
6. **Cam shaft**
7. **Anchor pin**

Rear Fork and Wheel

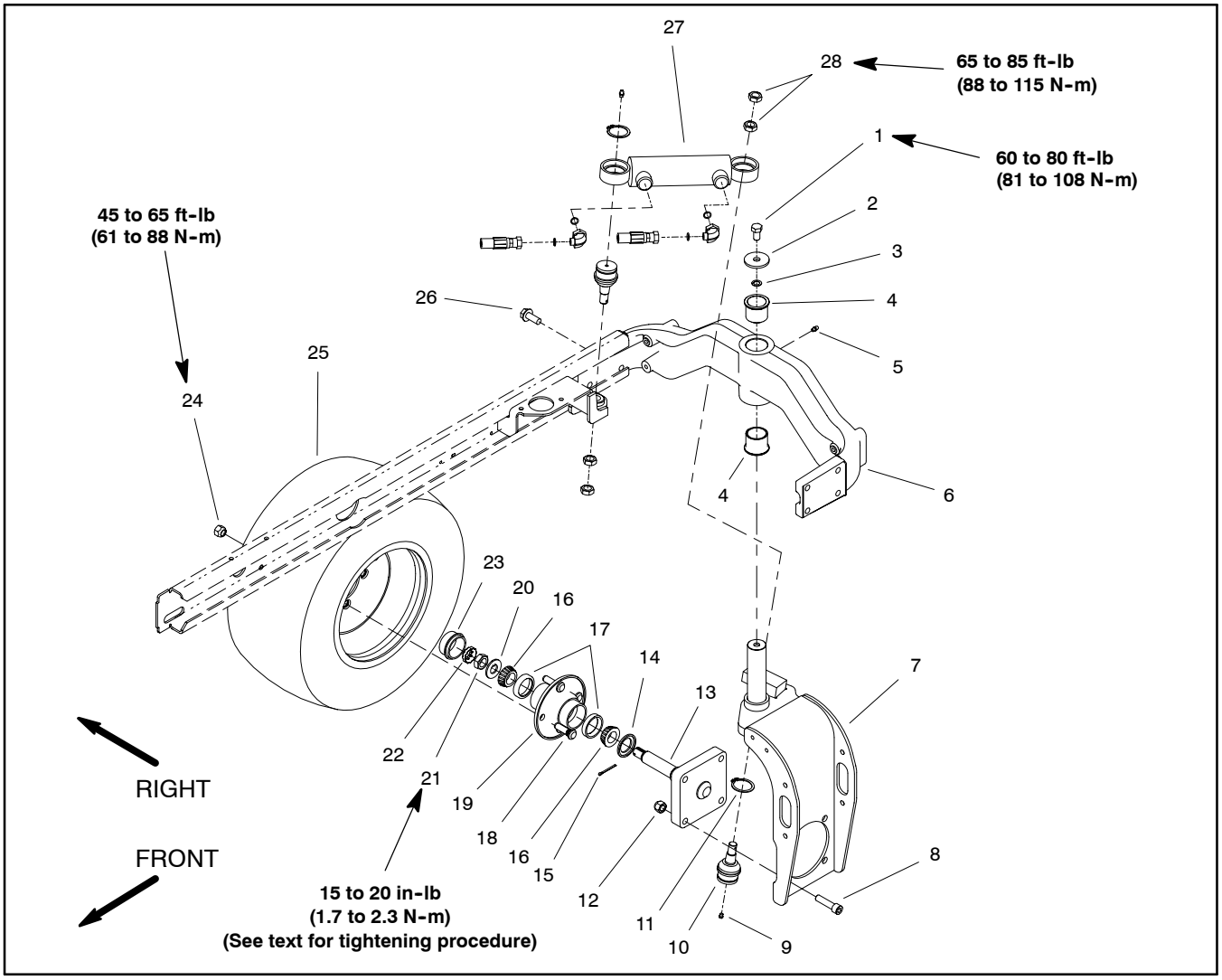

Figure 7

1. Cap screw
2. Thrust washer
3. Lock washer
4. Flange bushing
5. Grease fitting
6. Rear casting
7. Rear fork
8. Socket head screw (4 used)
9. Grease fitting plug
10. Ball joint
11. Retaining ring
12. Lock nut (4 used)
13. Hub
14. Seal
15. Cotter pin
16. Bearing cone
17. Bearing cup
18. Drive stud (4 used)
19. Wheel hub
20. Tab washer
21. Jam nut
22. Nut retainer
23. Dust cap
24. Lug nut (4 used)
25. Wheel and tire assembly
26. Flange head screw (8 used)
27. Hydraulic steering cylinder
28. Jam nut

Disassembly (Fig. 7)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. Remove hood from the machine (see Traction Unit Operator's Manual).

WARNING

Before jacking up the machine, review and follow Jacking Instructions in Chapter 1 - Safety.

3. Chock front wheels. Jack up rear wheel enough to allow the removal of the rear fork. Support machine with jack stands or blocking.

4. Remove lug nuts from rear wheel drive studs. Remove rear wheel assembly from machine.

5. Separate hydraulic steering cylinder from the rear fork as follows:

   A. Remove both jam nuts securing the ball joint to the rear fork.

   B. Separate ball joint from the rear fork.

   C. Swing steering cylinder clear of the rear fork.

6. Remove dust cap from hub. Remove cotter pin, nut retainer, jam nut and tab washer to allow removal of wheel hub and bearings. Pull wheel hub with bearings and seal from machine.

7. If necessary, remove seal and bearings from wheel hub.

8. Inspect bearing cups in wheel hub for wear or damage. If bearing cups are damaged, replace the wheel hub.

CAUTION

Support rear fork to prevent its falling during removal and installation. Personal injury or damage to the fork may result from improper handling.

9. Remove cap screw, thrust washer and lock washer from the rear fork shaft. Slide rear fork from machine.

10. Check flange bushings in rear casting for wear or damage. Replace bushings if necessary.

Assembly (Fig. 7)

1. Position rear fork through the frame.

2. Install lock washer, thrust washer and cap screw to the rear fork shaft. Torque cap screw from 60 to 80 ft-lb (81 to 108 N-m). Make sure fork turns freely after cap screw has been tightened.

3. If seal and inner bearing were removed from the wheel hub, place greased bearing cone into inner bearing cup. Install new seal.

4. Slide wheel hub onto machine. Position greased outer bearing and tab washer onto shaft.

5. Install jam nut onto shaft and tighten fully to seat bearings. Back off jam nut and then, while rotating wheel hub, torque nut from 15 to 20 in-lb (1.7 to 2.3 N-m).

6. Install nut retainer, cotter pin and dust cap.

7. Secure hydraulic steering cylinder to the rear fork as follows:

   A. Swing steering cylinder to the rear fork.

   B. Install ball joint to rear fork.

   C. Secure ball joint to rear fork with two (2) jam nuts. Tighten the first jam nut from 65 to 85 ft-lb (88 to 115 N-m), then tighten the second jam nut to the same specification.

8. Secure wheel assembly to the wheel hub with four (4) lug nuts.

9. Lower machine to the ground. Torque lug nuts in a crossing pattern from 45 to 65 ft-lb (61 to 88 N-m).

10. Lubricate grease fittings (see Traction Unit Operator's Manual).

Brake Lever Linkages

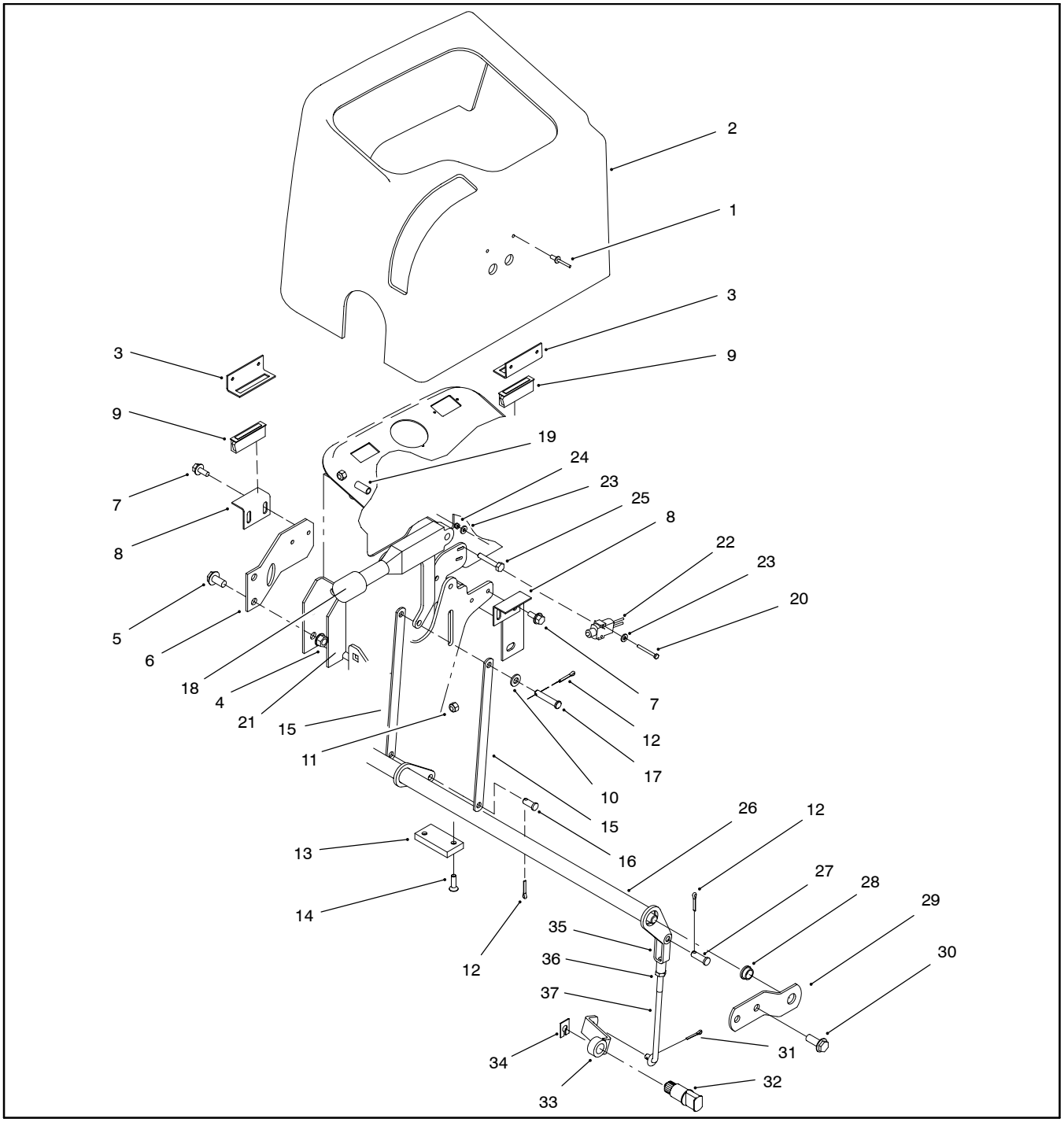

Figure 8

1. Pop rivet (4 used)
2. Control panel cover
3. Cover bracket
4. Flange nut (2 used)
5. Flange head screw (2 used)
6. Magnet support
7. Hex washer head screw (4 used)
8. Strike bracket
9. Magnetic catch
10. Flat washer
11. Lock nut (2 used)
12. Cotter pin
13. Bumper pad
14. Socket head screw (2 used)
15. Parking brake link
16. Clevis pin
17. Clevis pin
18. Lever assembly
19. Parking brake spacer
20. Slotted head screw (2 used)
21. Frame
22. Parking brake switch
23. Flat washer (4 used)
24. Lock nut (2 used)
25. Cap screw
26. Brake pivot shaft
27. Clevis pin (2 used)
28. Flange bushing (2 used)
29. Brake pivot bracket (2 used)
30. Hex flange head screw (4 used)
31. Cotter pin (2 used)
32. Brake cam shaft
33. Brake lever
34. Retainer clip
35. Adjustable clevis
36. Jam nut
37. Adjustment rod

Disassembly (Fig. 8)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. Remove control panel cover from the machine.

IMPORTANT: When removing the adjustable clevis from either the brake pivot shaft or adjustment rod or the brake lever from the cam shaft on the brake assembly, make sure to matchmark both parts. Marking both parts will make assembly and brake adjustment easier.

3. Remove parts as necessary using Figure 8 as a guide.

Assembly (Fig. 8)

1. Assemble components as necessary using Figure 8 as a guide.

2. Install control panel cover to the machine.

IMPORTANT: Always check and adjust brakes anytime brake linkages are disassembled or repaired.

3. Adjust brake linkages (see Adjust Brakes in the Adjustments section).

Steering Column

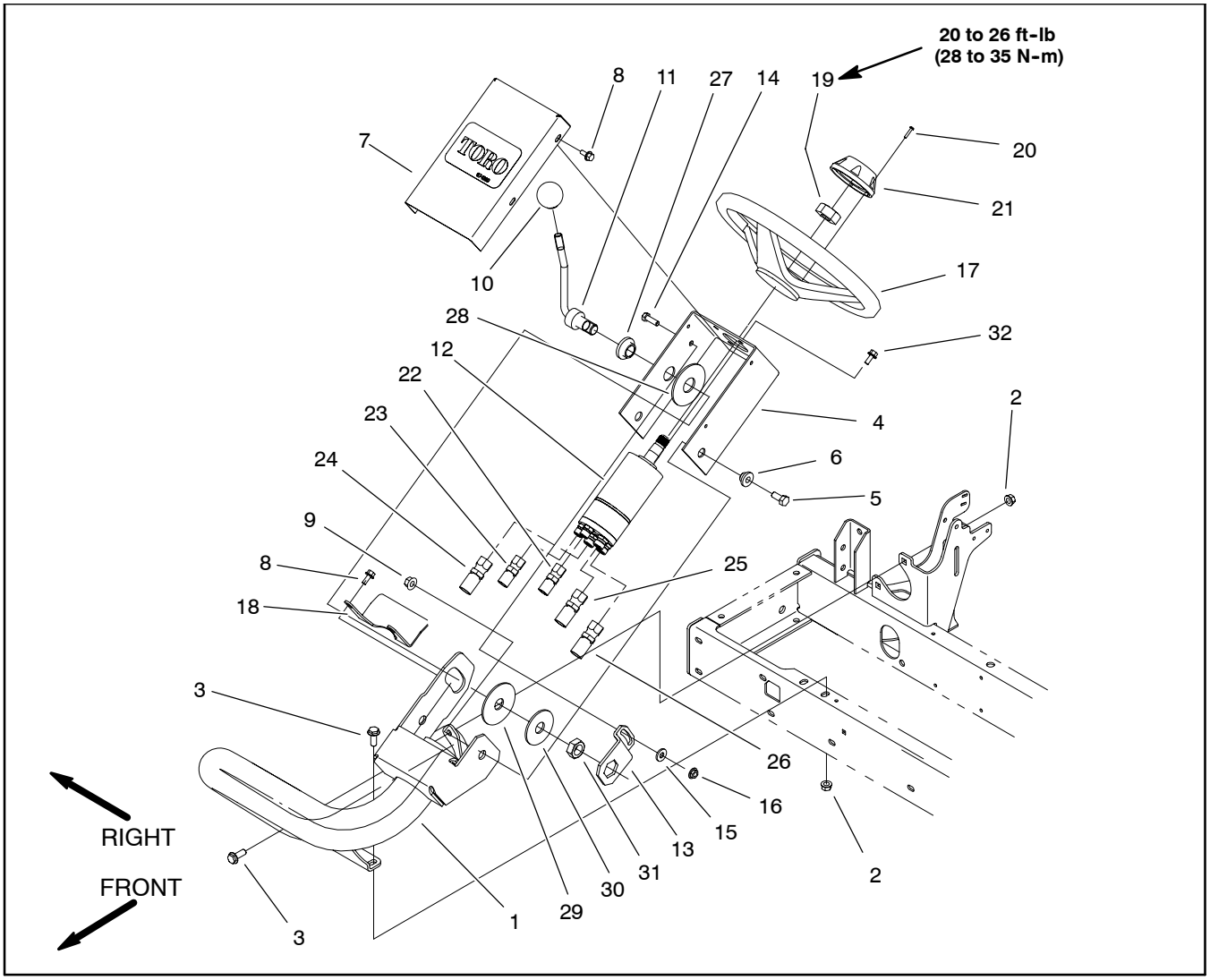

Figure 9

1. Steering arm
2. Flange nut
3. Flange head screw
4. Steering control valve bracket
5. Cap screw (2 used)
6. Pivot hub (2 used)
7. Steering cover
8. Washer head screw
9. Flange nut
10. Ball knob
11. Steering tilt lever
12. Steering control valve
13. Tilt bracket
14. Cap screw
15. Flat washer
16. Flange nut
17. Steering wheel
18. Steering shield
19. Steering wheel nut
20. Philips head screw
21. Steering wheel cap
22. Hydraulic hose
23. Hydraulic hose
24. Hydraulic hose
25. Hydraulic hose
26. Hydraulic hose
27. Tilt steering boss
28. Friction disc
29. Friction disc
30. Flat washer
31. Jam nut
32. Flange head screw (4 used)

Disassembly (Fig. 9)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. Remove philips head screw and steering wheel cap from the steering wheel.

3. Remove steering wheel nut from the steering control valve. Pull steering wheel from the steering control valve.

4. Remove steering cover (item 7) from the steering control valve bracket.

5. Remove four (4) flange head screws securing the steering control valve to the steering control valve bracket.

6. Remove both flange nuts, cap screws and pivot hubs securing the steering control valve bracket to the steering arm. Slide bracket from the steering control valve and steering arm.

7. Remove remaining parts as necessary to repair steering column using Figure 9 as a guide. If steering control valve requires service, see Steering Control Valve in the Service and Repairs section of Chapter 4 – Hydraulic System.

Assembly (Fig. 9)

1. Make sure lever and friction discs are properly assembled to the steering control valve bracket using Figures 9 and 10 as guides.

2. Position steering control bracket to the steering control valve and steering arm. Secure bracket to the steering arm with pivot hubs, cap screws and flange nuts.

3. Secure steering control valve bracket to the steering control valve with four (4) flange head screws.

4. Secure steering cover to the steering control valve bracket with washer head screws.

5. Install steering wheel to the steering control valve. Torque steering wheel nut from 20 to 26 ft–lb (28 to 35 N–m).

6. Secure steering wheel cap to the steering wheel with philips head screw.

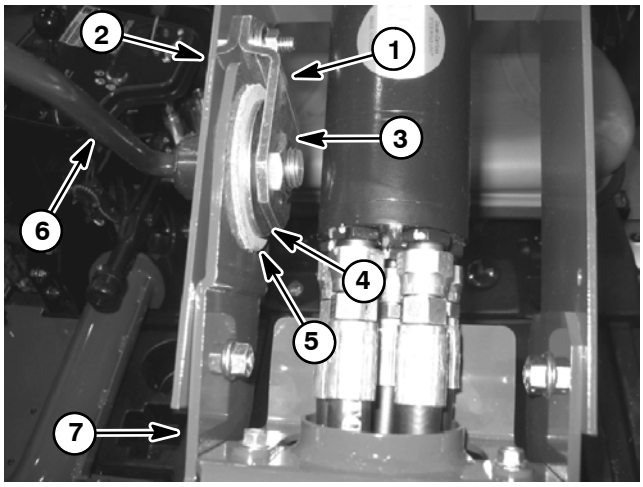

Figure 10

1. **Tilt bracket**
2. **Steering valve bracket**
3. **Jam nut**
4. **Flat washer**
5. **Friction disc**
6. **Steering tilt lever**
7. **Steering arm**

Front Lift Arms

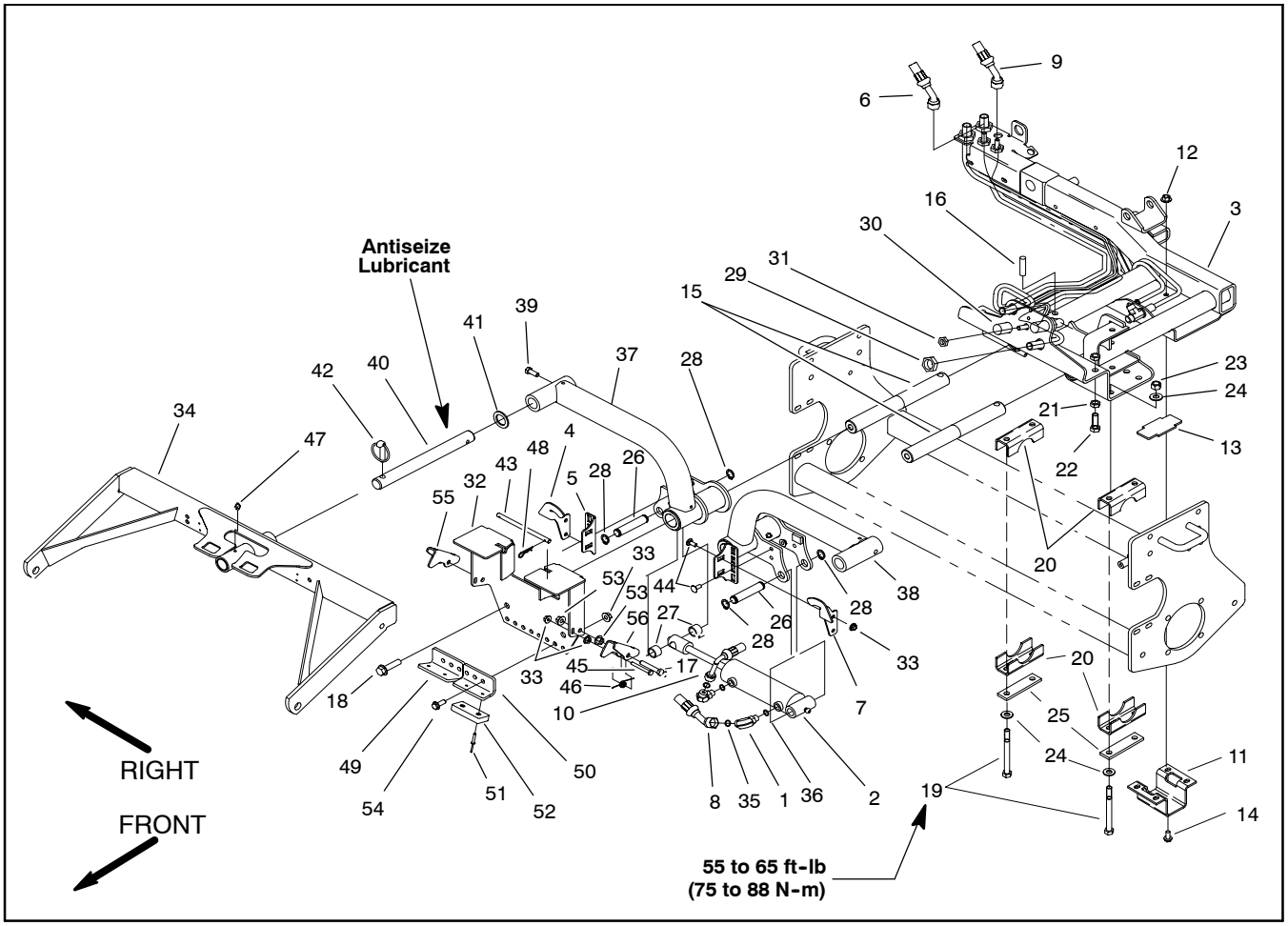

Figure 11

1. 90º hydraulic fitting (2 used)
2. Hydraulic cylinder
3. Carrier assembly
4. RH actuator
5. Actuator bracket (2 used)
6. Hydraulic hose
7. LH actuator
8. Hydraulic hose
9. Hydraulic hose
10. Hydraulic hose
11. Clamp bracket
12. Flange nut (12 used)
13. Plastic slide
14. Flange head screw (4 used)
15. Lift arm pivot shaft (2 used)
16. Roll pin (2 used)
17. Cap screw (2 used)
18. Flange head screw (2 used)
19. Cap screw (4 used)
20. Clamp (4 used)
21. Jam nut (4 used)
22. Cap screw (2 used)
23. Lock nut (4 used)
24. Thrust washer (8 used)
25. Support bar (2 used)
26. Pin (2 used)
27. Spacer (2 used)
28. External retaining ring (4 used)
29. Bulkhead nut (4 used)
30. Hydraulic tube
31. Bulkhead nut
32. Carrier stop bracket
33. Nut (12 used)
34. Front carrier frame (2 used)
35. O-ring (2 used)
36. O-ring (2 used)
37. RH liftarm
38. LH liftarm
39. Cap screw (2 used)
40. Carrier frame pivot shaft (2 used)
41. Thrust washer (2 used)
42. Lynch pin (2 used)
43. Rod
44. Carriage screw (8 used)
45. Cap screw (2 used)
46. Torsion spring (2 used)
47. Grease fitting (2 used)
48. Hair pin (2 used)
49. RH deck stop
50. LH deck stop
51. Rivet (4 used)
52. Rubber bumper (2 used)
53. Flange nut (12 used)
54. Flange head screw (4 used)
55. RH pivot bracket
56. LH pivot bracket

Removal (Fig. 11)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. Remove cutting units from the pivot shaft of the front lift arms (see Cutting Unit Operator's Manual).

NOTE: Remove both spacers from the hydraulic cylinder shaft clevis when removing the right, front lift arm.

3. Disconnect hydraulic cylinder from the front lift arms by removing external retaining rings and pins.

4. Remove both flange head screws and carrier stop bracket from the lift arm pivot shafts.

5. Slide lift arm off the pivot shaft.

6. Disassemble lift arm as necessary using Figure 11 as a guide.

7. Inspect bushings in lift arm and carrier frame (Fig 12). If bushings are worn or damaged, replace bushings.

Installation (Fig. 11)

1. Assemble lift arm using Figure 11 as a guide.

   A. If clamps (item 20) were removed, torque cap screws (item 20) from 55 to 65 ft-lb (75 to 88 N-m).

   B. If carrier frame pivot shaft (item 40) was removed, apply antiseize lubricant to pivot shaft before installing carrier frame.

2. Slide lift arm onto the lift arm pivot shaft.

3. Secure carrier stop bracket with both flange head screws to the lift arm pivot shafts.

NOTE: Install both spacers to the hydraulic cylinder shaft clevis when installing the right, front lift arm.

4. Secure hydraulic cylinder to the lift arm with pins and external retaining rings.

5. Route hydraulic hoses so they clear the lift arm by 0.040" to 0.120" (1.0 to 3.0 mm) when the lift arm is fully raised (Fig. 13).

6. Adjust lift arms for proper clearance (see Traction Unit Operator's Manual).

7. Install cutting unit to the front lift arm pivot shaft (see Cutting Unit Operator's Manual).

8. Grease front lift arms (see Traction Unit Operator's Manual).

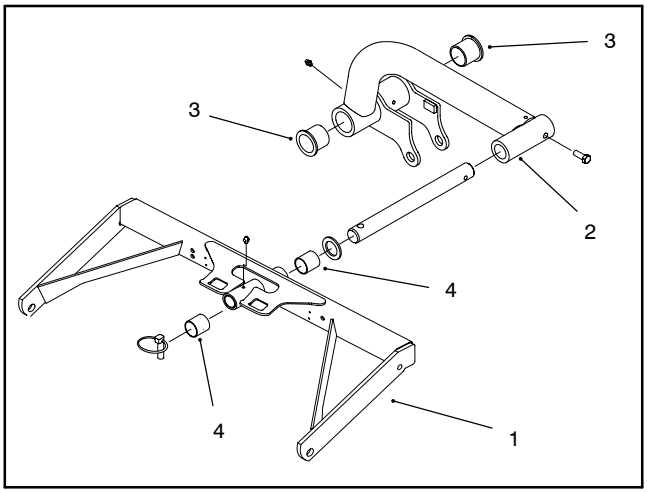

Figure 12

1. **Carrier frame**
2. **Front lift arm (LH shown)**
3. **Lift arm bushing**
4. **Frame bushing**

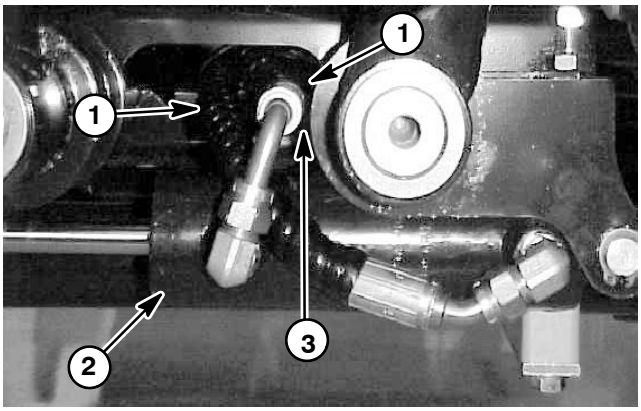

Figure 13

1. **Hydraulic hose**
2. **Hydraulic cylinder**
3. **Clearance**

Rear Lift Arm

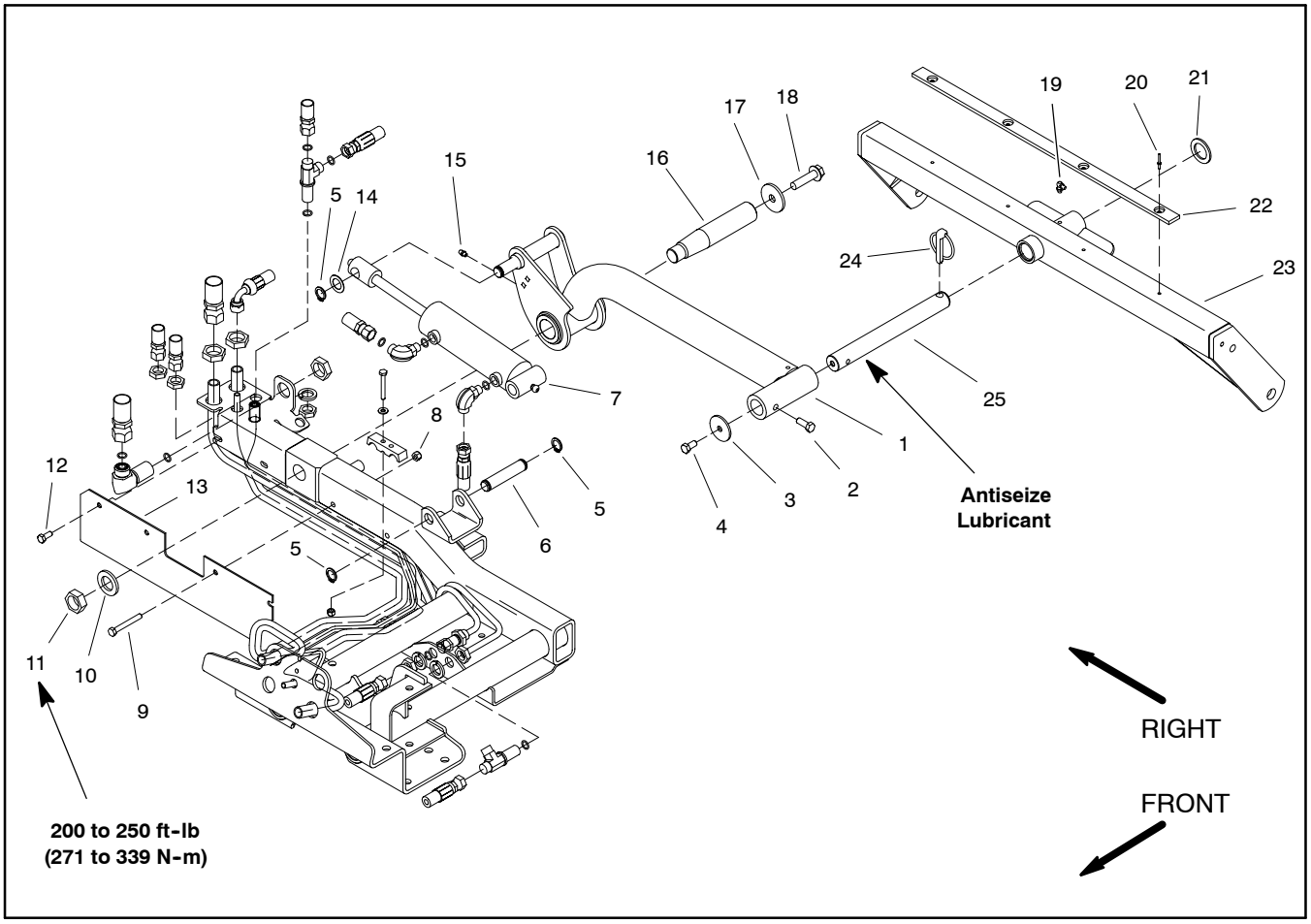

Figure 14

1. Rear lift arm
2. Cap screw
3. Washer
4. Cap screw
5. Retaining ring (3 used)
6. Pin
7. Hydraulic lift cylinder
8. Flange nut (4 used)
9. Cap screw (2 used)
10. Washer
11. Jam nut
12. Cap screw (2 used)
13. Guard
14. Thrust washer
15. Grease fitting
16. Lift arm pivot shaft
17. Thrust washer
18. Flange screw
19. Grease fitting
20. Pop rivet (4 used)
21. Thrust washer
22. Wear strip
23. Rear carrier frame
24. Lynch pin
25. Carrier frame pivot shaft

Removal (Fig. 14)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. Remove cutting unit from the pivot shaft of the rear lift arm (see Cutting Unit Operator's Manual).

3. Remove external retaining ring and thrust washer from the hydraulic lift cylinder shaft of the rear lift arm.

4. Remove flange head screw and thrust washer from the rear pivot shaft.

5. Slide rear lift arm from rear pivot shaft and hydraulic lift cylinder.

6. Disassemble lift arm as necessary using Figure 14 as a guide.

7. Inspect bushings in lift arm and carrier frame (Fig 15). If bushings are worn or damaged, replace bushings.

Installation (Fig. 14)

1. Assemble lift arm using Figure 14 as a guide.

   A. If the rear lift arm pivot shaft (item 16) was removed from frame, thoroughly clean tapered surfaces of shaft and frame. Position pivot shaft to frame and secure with washer and jam nut. Torque jam nut from 200 to 250 ft–lb (271 to 339 N–m).

   B. If the carrier frame pivot shaft (item 25) was removed from lift arm, apply antiseize lubricant to pivot shaft before inserting into lift arm. Secure pivot shaft with two (2) cap screws (items 2 and 4) and washer (item 3).

2. Slide rear lift arm onto rear pivot shaft making sure that the lift cylinder shaft of the rear lift arm slides into the clevis of the hydraulic lift cylinder.

3. Secure hydraulic cylinder clevis to the lift cylinder shaft of the rear lift arm with the thrust washer and external retaining ring.

4. Install rear cutting unit to the pivot shaft of the rear lift arm (see Cutting Unit Operator's Manual).

5. Adjust lift arm for proper clearance (see Traction Unit Operator's Manual).

IMPORTANT: Make sure hydraulic hoses are free of twists and sharp bends. Raise cutting units and make sure that rear cutting unit hoses do not contact the traction cable bracket. If required, reposition fittings and hoses.

6. Grease rear lift arm (see Traction Unit Operator's Manual).

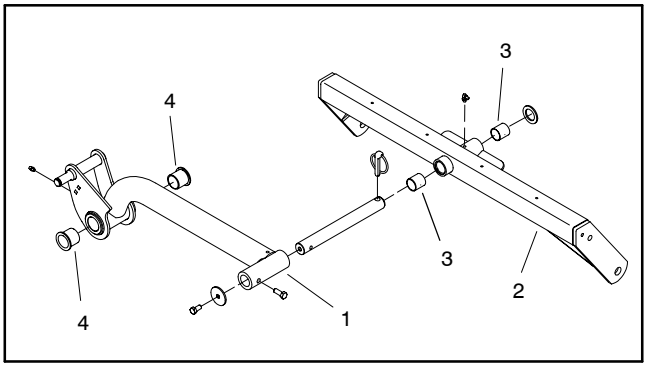

Figure 15

1. **Rear lift arm**
2. **Carrier frame**
3. **Frame bushing**
4. **Lift arm bushing**

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Chapter 7

Cutting Units

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Specifications

MOUNTING: All cutting units are supported by equal length, independent lift arms and are interchangeable to all three cutting unit positions.

CONSTRUCTION: Deck chamber is welded 7, 10 and 12 gauge steel. Deck frame is welded 1-1/2 inch square tubing with 7 gauge side supports.

HEIGHT-OF-CUT RANGE: 3/4 to 4 inch (1.9 to 10.2 cm) in 1/4 inch (6.4 mm) increments. Height-of-cut adjustment is made by repositioning deck on deck frame.

DECK DRIVE: Closed loop, integrated relief, hydraulic system operates cutting deck hydraulic motors. Blade spindles are 1-1/4 inch shafts supported by greaseable, tapered roller bearings.

CUTTING BLADE: Each cutting unit equipped with 27 inch (68.6 cm) length, .25 inch (6.4 mm) thick, heat treated, steel blade. Anti-scalp cup installed on cutting blade.

DISCHARGE: Clippings are discharged from the rear of the cutting deck. Pre-drilled mounting holes allow attachment of optional mulching baffle.

CUTTING UNIT LIFT: Cutting units are controlled with one lever.

SUSPENSION SYSTEM: A fully floating suspension with hydraulic counterbalance. Individual decks supported with two front rollers and one, full width, rear roller.

WEIGHT: Complete cutting unit weighs 210 lb (95 kg).

Special Tools

Order these special tools from your Toro Distributor.

Cutting Unit Tool Kit - TOR4070

This tool kit includes special tools used to assemble the cutting unit rear roller that has greasable bearings with a grease fitting on the ends of the roller shaft.

TOR4064	Spanner Wrench
TOR4065	Inner Oil Seal Installer
TOR4066	Bearing Installer
TOR4067	Shaft Support Tool
TOR4068	Inner Seal Installer
TOR4869	Outer Seal Installer
TOR4071	Outer Oil Seal Installer
TOR4072	Shaft Seal Protector
TOR4073	Handle
TOR4074	Spline Insert Tool

Figure 1

Rear Roller Grease Nozzle - 107-1998

This tool is used to grease the cutting unit rear roller bearings.

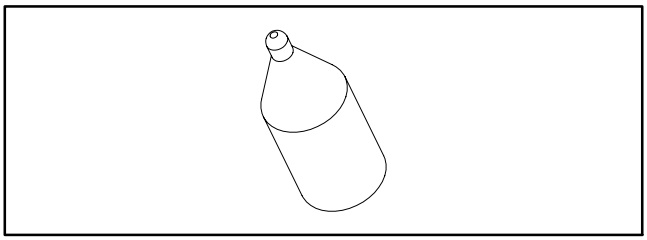

Figure 2

Rear Roller Bearing and Seal Installation Tools

These tools are used to assemble the cutting unit rear roller that has greasable bearings and a bearing lock nut used to retain the bearings.

115-0852	Inner Seal Tool
115-0853	Bearing/Outer Seal Tool
107-8133	Bearing Installation Washer

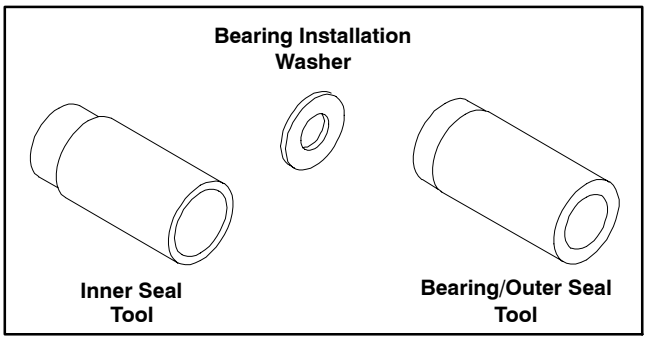

Figure 3

Troubleshooting

There are a number of factors that can contribute to unsatisfactory quality of cut, some of which may be turf conditions. Turf conditions such as excessive thatch, “sponginess” or attempting to cut off too much grass height may not always be overcome by adjusting the machine. It is important to remember that the lower the height−of−cut, the more critical these factors are.

Remember that the “effective” or actual height−of−cut depends on cutting unit weight and turf conditions. Effective height−of−cut will be different than the bench set height−of−cut.

Factors That Can Affect Quality of Cut

Factor	Possible Problem/Correction
1. Maximum governed engine speed.	Check maximum governed engine speed. Adjust speed to specifications if necessary.
2. Blade speed.	All deck blades should rotate at the same speed. See items in Troubleshooting Section of Chapter 4 − Hydraulic System.
3. Tire pressure.	Check each tire’s pressure. Adjust to pressures specified in Traction Unit Operator’s Manual.
4. Blade condition.	Sharpen blades if their cutting edges are dull or nicked. Inspect blade sail for wear or damage. Replace blade if needed.
5. Mower housing condition.	Make sure that cutting chambers are in good condition. Keep underside of deck clean. Debris buildup will reduce cutting performance.
6. Height−of−cut.	Make sure all cutting units are set at the same height−of−cut. Set units as specified in the Cutting Unit Operator’s Manual.
7. Cutting unit alignment and ground following.	Check lift arms and cutting unit pivot linkages for wear, damage or binding. Also inspect for bent or damaged pivot shafts.
8. Roller condition.	All rollers should rotate freely. Replace bearings if worn or damaged.

Adjustments

CAUTION

Never adjust or work on the cutting units or lift arms with the engine running. Always stop engine and remove key first.

Refer to the Cutting Unit Operator's Manual regarding adjustment procedures for Groundsmaster 3505–D cutting decks.

Blade Stopping Time

The blades of the cutting decks should come to a complete stop in approximately 5 seconds after the PTO switch is disengaged.

NOTE: When checking blade stopping time, make sure the decks are lowered onto a clean section of turf or hard surface to avoid dust and debris.

To verify blade stopping time, have a second person stand back a safe distance from the machine and watch the blade on one of the cutting decks. When the machine operator disengages the cutting decks, record the time it takes for the blade to come to a complete stop. If this time is greater than 7 seconds, the braking valve (BV) on the hydraulic manifold needs adjustment (see Braking Valve Adjustment in the Adjustments section of Chapter 4 – Hydraulic System).

Service and Repairs

CAUTION

Never install or work on the cutting units or lift arms with the engine running. Always stop engine and remove key first.

Rear Roller

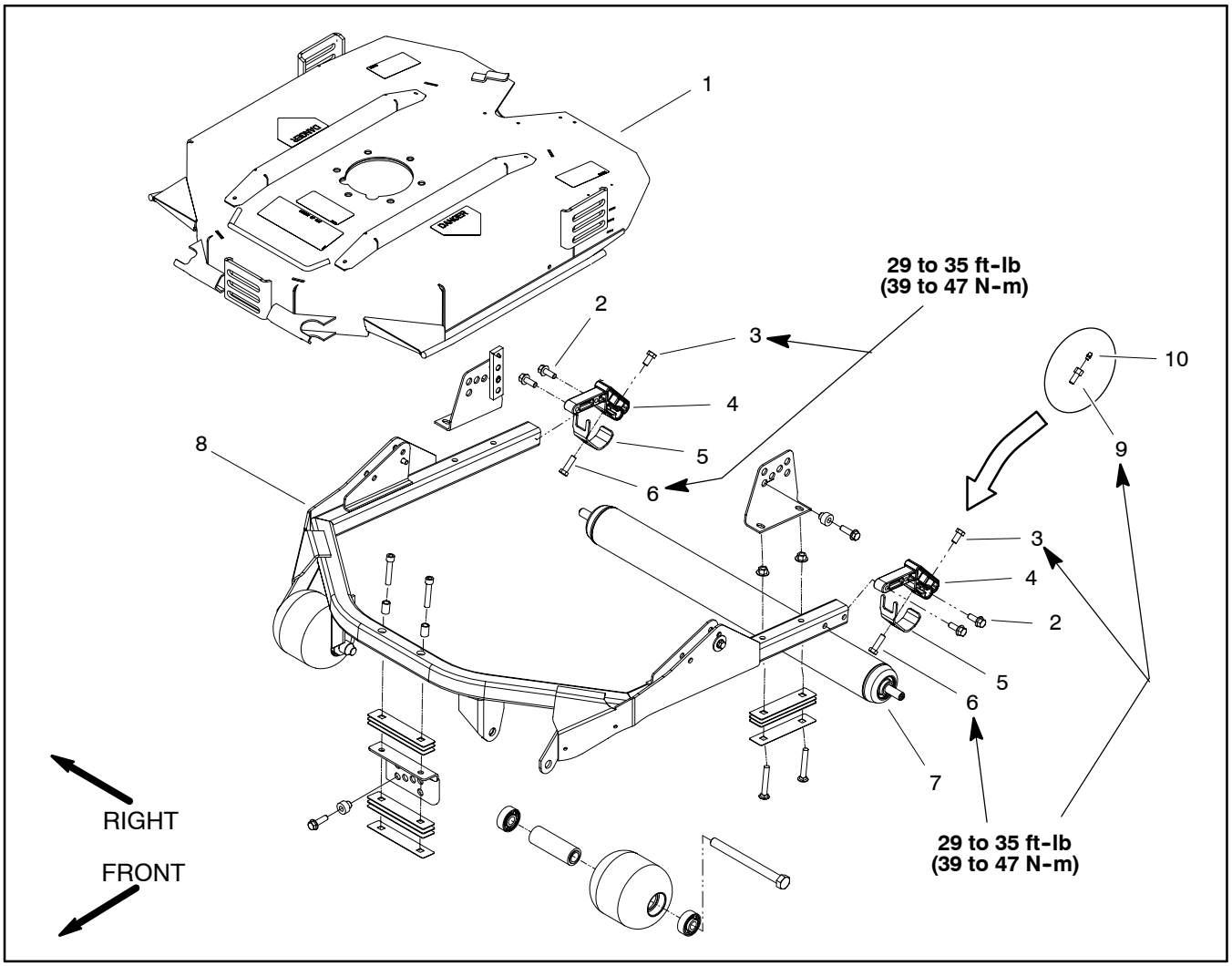

Figure 4

1. Cutting deck
2. Flange head screw (4 used)
3. Cap screw
4. Roller mount
5. Skid bracket
6. Cap screw
7. Rear roller assembly
8. Cutting deck frame
9. Cap screw (if equipped)
10. Grease fitting

Removal (Fig. 4)

1. If cutting unit is equipped with rear roller scraper, remove fasteners securing left and right scraper rod brackets to roller mounts (Fig. 5). Remove scraper rod assembly.

2. Remove four (4) flange head screws that secure roller mounts to rear of deck frame. Remove roller mounts and rear roller assembly from deck frame.

3. Loosen cap screws securing each end of roller to roller mounts. Remove mounts from roller.

Installation (Fig. 4)

1. Place roller assembly into roller mounts.

2. Install roller and roller mount assembly into rear of deck frame. Secure assembly to deck frame with four (4) flange head screws.

IMPORTANT: If roller design includes grease fittings in roller fasteners (items 9 and 10 in Fig. 4), make sure the grease groove in each roller mount aligns with the grease hole in each end of the roller shaft. To help align the groove and hole, there is also an alignment mark on one end of the roller shaft.

3. If equipped with scraper rod, install and adjust scraper rod assembly to roller mounts (Fig. 5). Torque cap screws 30 ft-lb (41 N-m) and tighten jam nut to secure scraper rod and rear roller to cutting deck.

4. Tighten cap screws securing each end of roller to roller mounts. Torque screws from 29 to 35 ft-lb (39 to 47 N-m).

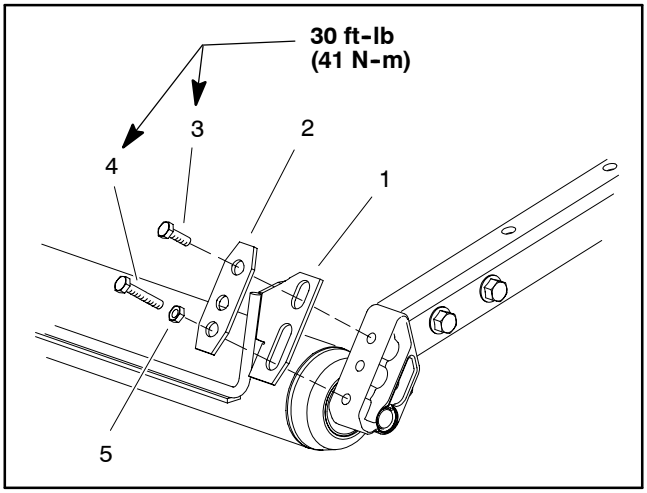

Figure 5

1. **Roller scraper**
2. **Scraper plate**
3. **Cap screw**
4. **Cap screw**
5. **Jam nut**

Rear Roller Service (Greasable Bearings with Retaining Ring)

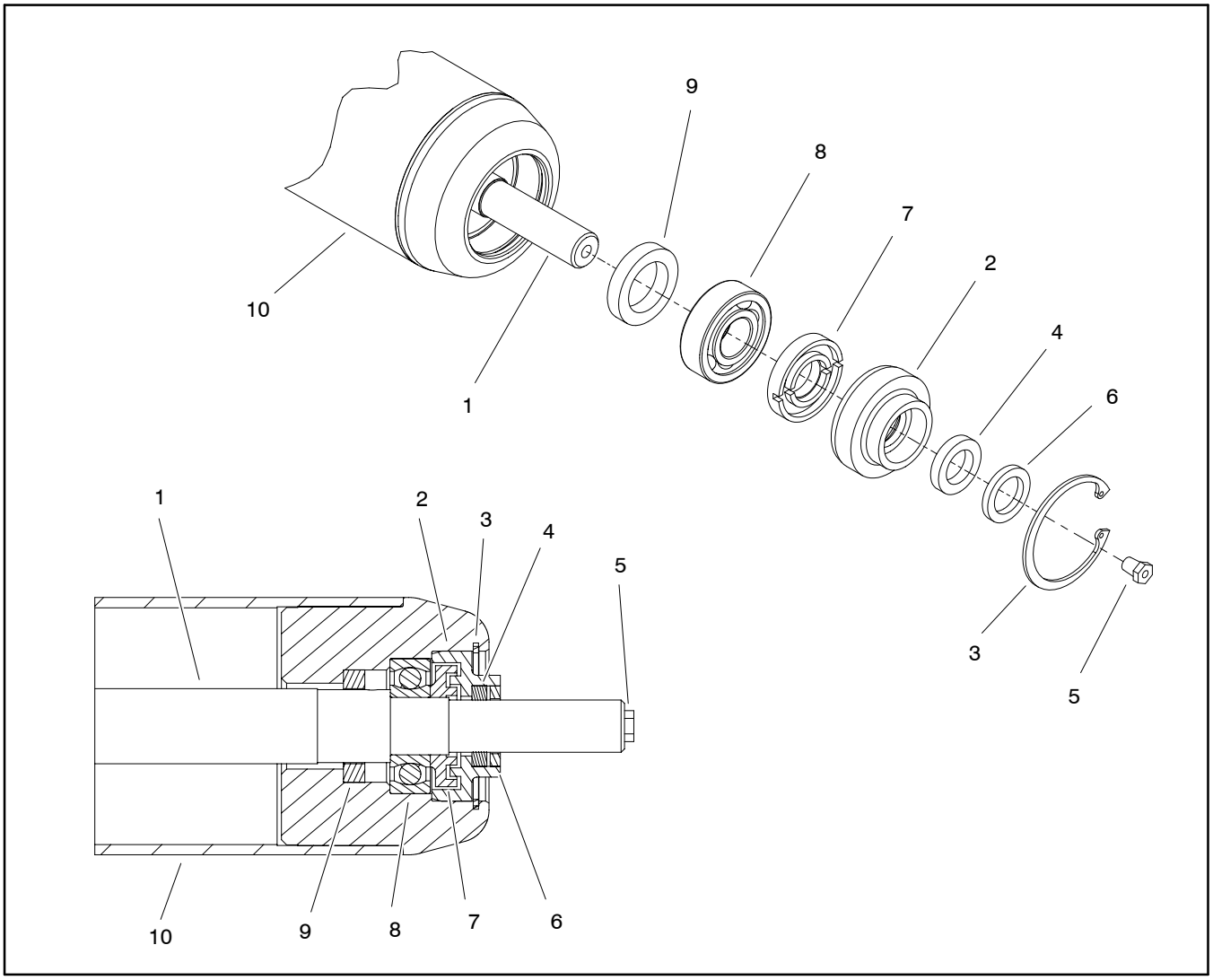

Figure 6

1. **Roller shaft**
2. **Outer seal**
3. **Retaining ring**
4. **Outer oil seal**
5. **Grease fitting**
6. **Washer**
7. **Inner seal**
8. **Ball bearing**
9. **Inner oil seal**
10. **Roller tube**

Roller Disassembly (Fig. 6)

1. Remove retaining ring from both ends of roller.

2. Hit end of roller shaft with a soft face hammer to remove seals and bearing from one end of roller. Hit other end of roller shaft to remove seals and bearing from other end of roller. Be careful not to drop roller shaft.

3. Discard seals and bearings.

Roller Assembly (Fig. 6)

NOTE: A soft face hammer can be used with the special tools listed (see Special Tools) to assemble the roller, however use of a press is recommended.

1. Use installation tool TOR4065 and handle TOR4073 to install inner oil seal into each end of roller tube.

2. Install ball bearings:

NOTE: Ball bearings have a press fit into the roller tube and a slip fit onto the roller shaft.

IMPORTANT: If ball bearing has a seal on one side, install bearing with seal orientated toward the outside of the roller.

A. Use tool TOR4066 and handle TOR4073 to install ball bearing into one end of roller tube.

B. Install roller shaft from opposite end of roller. Be careful not to damage the inner oil seals.

C. Put roller in a vertical position and support shaft and bearing with tool TOR4067.

D. Use tool TOR4067 to install second ball bearing.

3. Use tool TOR4068 to install inner seal.

4. Use tool TOR4069 to install outer seal.

5. Install retaining ring so that side with sharp edges faces end of roller (out).

6. Use tool TOR4071 to install outer oil seal.

7. Use tool TOR4067 to install washer.

8. Put opposite end of roller facing up and support bottom end with tool TOR4067. Repeat steps 3 - 7.

9. Use a hand operated grease gun and No. 2 general purpose lithium base grease to lubricate bearings until grease appears at washer. Wipe off excess grease.

Rear Roller Service (Greasable Bearings with Bearing Nut)

Disassembly (Fig. 7)

1. Remove bearing lock nut from each end of roller shaft.

2. Loosely secure roller assembly in bench vise and lightly tap one end of roller shaft until outer seals and bearing are removed from opposite end of roller tube. Remove second set of outer seals and bearing from roller tube by tapping on opposite end of shaft. Remove shaft from roller tube.

3. Carefully remove inner seal from both ends of roller tube taking care to not damage tube surfaces.

4. Discard removed seals and bearings.

5. Clean roller shaft and all surfaces on the inside of the roller tube. Inspect components for wear or damage. Also, carefully inspect seating surface and threads of bearing lock nuts. Replace all damaged components.

Assembly (Fig. 7)

1. Install inner seals into roller tube making sure that seal lip (and garter spring) faces end of tube. Use inner seal tool (see Special Tools) and soft face hammer to fully seat seals against roller shoulder (Fig. 8). Apply a small amount of grease around the lip of both inner seals after installation.

IMPORTANT: During assembly process, frequently check that bearings rotate freely and do not bind. If any binding is detected, consider component removal and reinstallation.

2. Install new bearing and outer seals into one end of roller tube:

   A. Position a new bearing into one end of roller tube. Use bearing/outer seal tool (see Special Tools) with a soft face hammer to fully seat bearing against roller shoulder (Fig. 9). After bearing installation, make sure that it rotates freely with no binding.

   B. Apply a small amount of grease around the lip of both outer seals.

   C. Install first outer seal into roller tube making sure that seal lip (and garter spring) faces end of tube. Use bearing/outer seal tool (see Special Tools) and soft face hammer to lightly seat seal against roller shoulder (Fig. 10). Make sure that bearing still freely rotates after seal installation.

   D. Using the same process, install second outer seal making sure to not crush the installed outer seal. Again, make sure that bearing still freely rotates.

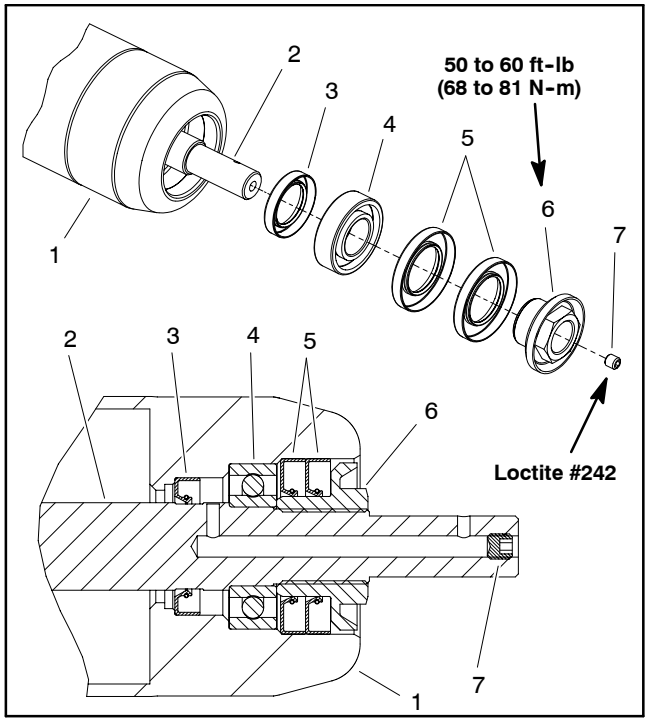

Figure 7

1. **Roller tube**
2. **Roller shaft**
3. **Inner seal**
4. **Bearing**
5. **Outer seal**
6. **Bearing lock nut**
7. **Set screw**

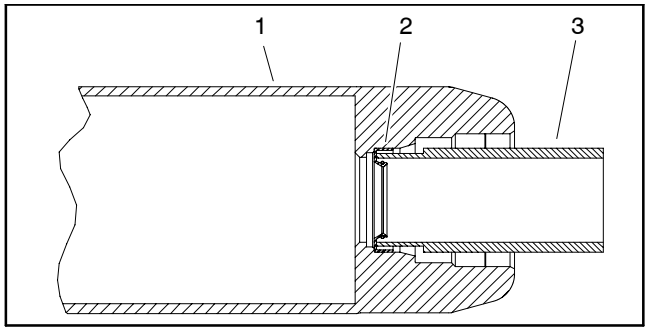

Figure 8

1. **Roller tube**
2. **Inner seal**
3. **Inner seal tool**

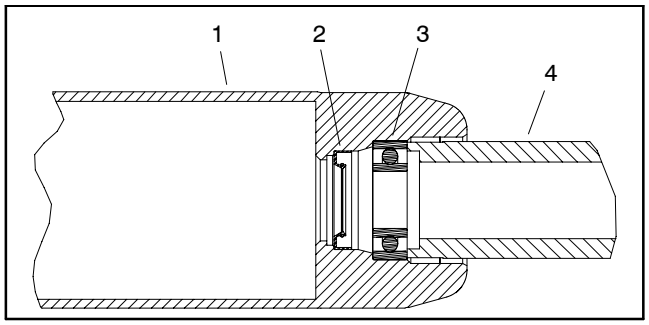

Figure 9

1. **Roller tube**
2. **Inner seal**
3. **Bearing**
4. **Washer**
5. **Bearing/outer seal tool**

3. From the roller tube end with only the inner seal installed, carefully install the roller shaft into the roller tube. Make sure that seals are not damaged as shaft is installed.

4. Install new bearing and outer seals into second end of roller tube:

A. Position a second new bearing to roller shaft and tube. Position washer (see Special Tools) on bearing to allow pressing on both inner and outer bearing races simultaneously.

B. Use washer and bearing/outer seal tool (see Special Tools) with a soft face hammer to fully seat bearing (Fig. 11). After bearing installation, make sure that shaft freely rotates and that no binding is detected. If necessary, lightly tap bearing and/or shaft ends to align shaft and bearings. Remove washer from roller.

C. Apply a small amount of grease around the lip of both outer seals.

D. Carefully install first outer seal into roller tube making sure that seal lip (and garter spring) faces end of tube. Use bearing/outer seal tool (see Special Tools) and soft face hammer to lightly seat seal (Fig. 12). Make sure that shaft and bearings still freely rotate after seal installation.

E. Using the same process, install second outer seal making sure to not crush the installed outer seal. Again, make sure that shaft and bearings still freely rotate.

IMPORTANT: Make sure that all grease is removed from shaft threads to prevent bearing lock nut loosening.

5. Thoroughly clean threads on both ends of roller shaft.

NOTE: If original bearing lock nut(s) are being used, apply Loctite #242 (or equivalent) to threads of lock nut(s).

6. Install bearing lock nut onto each end of the roller shaft. Make sure that outer seals are not damaged during nut installation. Torque lock nuts from 50 to 60 ft-lb (68 to 81 N-m).

7. If set screw was removed from either end of roller shaft, apply Loctite #242 (or equivalent) to threads of removed set screw and install into roller shaft. Tighten set screw until it bottoms in shaft and is recessed in shaft.

IMPORTANT: When roller assembly is installed to cutting deck, make sure that grease groove in each roller mount aligns with the grease hole in each end of roller shaft.

NOTE: After roller is installed to cutting deck, lubricate roller grease fittings, rotate roller to properly distribute grease in bearings and clean excess grease from roller ends. A properly assembled roller should rotate with less than 5 in-lbs (0.68 N-m) resistance.

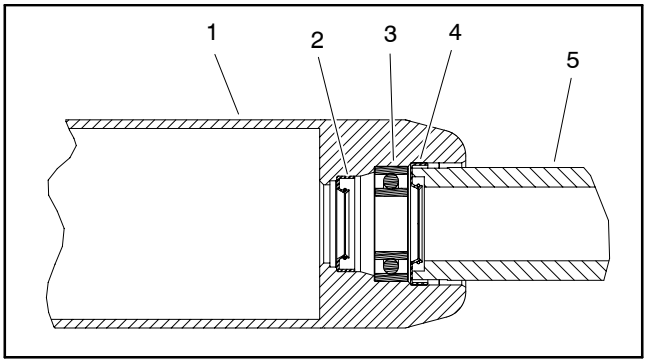

Figure 10

1. **Roller tube**
2. **Inner seal**
3. **Bearing**
4. **Outer seal**
5. **Bearing/outer seal tool**

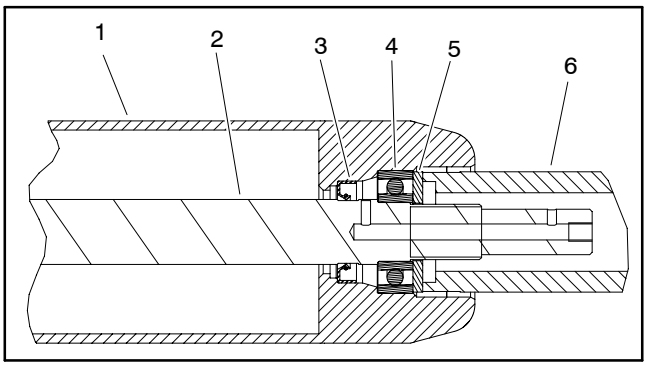

Figure 11

1. **Roller tube**
2. **Roller shaft**
3. **Inner seal**
4. **Bearing**
5. **Washer**
6. **Bearing/outer seal tool**

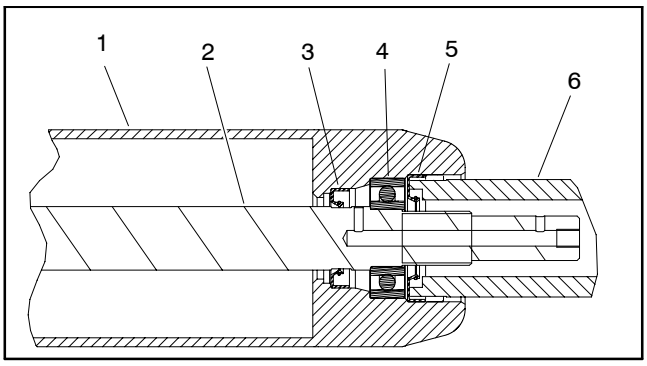

Figure 12

1. **Roller tube**
2. **Roller shaft**
3. **Inner seal**
4. **Bearing**
5. **Outer seal**
6. **Bearing/outer seal tool**

Blade Spindle

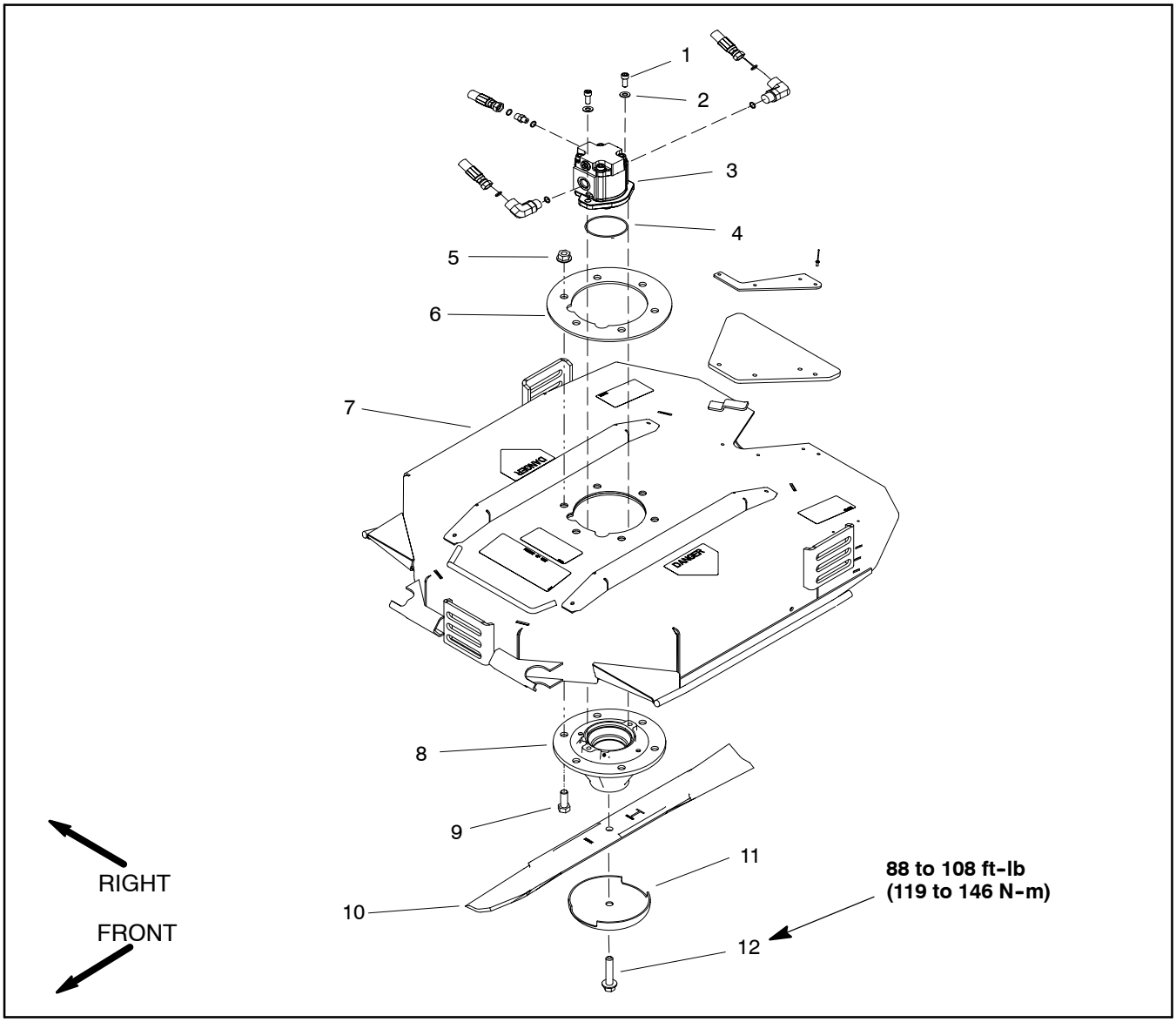

Figure 13

1. **Socket head screw (2 per motor)**
2. **Flat washer (2 per motor)**
3. **Hydraulic deck motor**
4. **O-ring**
5. **Flange nut (6 used)**
6. **Spindle plate**
7. **Cutting deck**
8. **Spindle assembly**
9. **Cap screw (6 used)**
10. **Cutting blade**
11. **Anti-scalp cup**
12. **Blade bolt**

Removal (Fig. 13)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. Remove two (2) socket head screws and flat washers that secure hydraulic motor to the cutting unit (Fig. 14). Remove hydraulic motor from deck. Locate and retrieve o-ring from top of spindle housing.

3. Cover top of spindle to prevent contamination. Spindle plug (Toro Part # 94-2703) can be used to cover spindle.

4. Start the engine and raise the cutting unit. Stop engine and remove key from the ignition switch. Support the cutting unit so it cannot lower accidentally. If required for easier service, remove cutting unit from machine (see Cutting Unit Operator's Manual).

5. Remove cutting blade bolt, anti-scalp cup and cutting blade (see Cutting Unit Operator's Manual).

6. Remove six (6) cap screws and flange nuts securing spindle housing to deck. Lower spindle assembly out the bottom of the deck. Remove spindle plate from top of deck.

Installation (Fig. 13)

1. Place spindle plate on cutting deck making sure to align notches in plate and cutting deck.

2. Position spindle housing to underside of cutting deck making sure that grease fitting is toward the front of the deck.

3. Secure spindle housing and spindle plate to cutting deck with six (6) cap screws and flange nuts.

4. Install cutting blade, anti−scalp cup and bolt (see Cutting Unit Operator's Manual). Tighten blade bolt from 88 to 108 ft−lb (119 to 146 N−m).

5. Position O−ring to top of spindle housing.

6. Position hydraulic deck motor to cutting deck making sure to align motor shaft splines with spindle shaft splines.

7. Secure hydraulic deck motor to the cutting unit with two (2) socket head screws and flat washers.

IMPORTANT: When greasing spindles on the Groundsmaster 3505−D, grease passes into the center of the spindle shaft and out to fill the bearing cavity of the housing. If grease does not come out of lower seal when greasing, check lubrication hole in spindle shaft for obstruction.

NOTE: Pneumatic grease guns can produce air pockets when filling large cavities. Use a hand pump grease gun when adding grease to spindle housing.

8. Using a hand pump grease gun, fill spindle housing cavity with grease until grease starts to come out of lower seal.

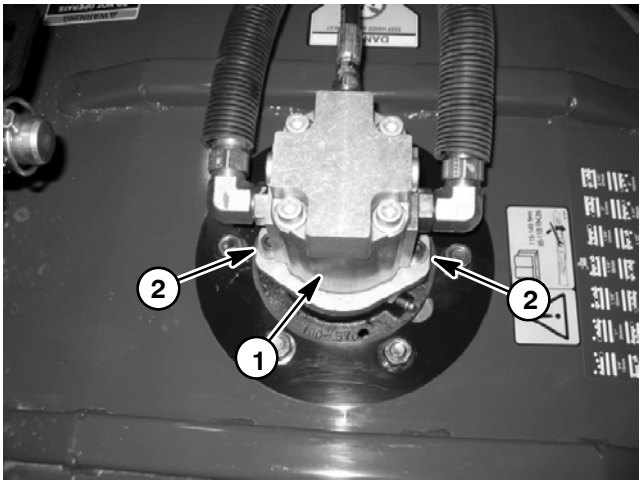

Figure 14

1. **Hydraulic deck motor**
2. **Socket head screw**

Blade Spindle Service

Disassembly (Fig. 15)

1. Loosen and remove spindle nut from top of spindle shaft.

2. Press the spindle shaft out of the spindle housing using an arbor press. The shaft spacer remains on the spindle shaft as the shaft is being removed.

3. Remove seals from spindle housing.

4. Allow the bearings, inside spacer and spacer ring to fall out of the spindle housing.

5. Using a punch and hammer, drive both of the bearing cups out of the spindle housing. Also drive the large spacer out of the housing.

6. The large snap ring should remain inside the spindle housing because it is difficult to remove.

Assembly (Fig. 15)

IMPORTANT: If new bearings will be installed into a used spindle housing it may not be necessary to replace the original large snap ring. If the original snap ring is in good condition with no evidence of damage (e.g. spun bearing), leave the snap ring in the housing and discard the snap ring that came with the new bearings. However, new bearings with their matched spacer set and large snap ring must ALWAYS be installed when the spindle housing is being replaced. Replacement bearings are sold only with a matched snap ring and spacer set (Fig. 16). These parts cannot be purchased separately.

1. If large snap ring was removed or if replacing the spindle housing, install large snap ring into spindle housing groove. Make sure snap ring is seated in groove.

IMPORTANT: If bearings are being replaced, make sure to use the large spacer, inside spacer and spacer ring that are included in new bearing set.

2. Using an arbor press, push large spacer into top of spindle housing. The spacer should fit tightly against the large snap ring.

3. Thoroughly oil the bearing cups. Using an arbor press, push the bearing cups into the top and bottom of the spindle housing. The top bearing cup must contact the spacer previously installed and the bottom bearing cup must contact the snap ring. Make sure that the assembly is correct by supporting the first bearing cup and pressing the second against it (Fig 17).

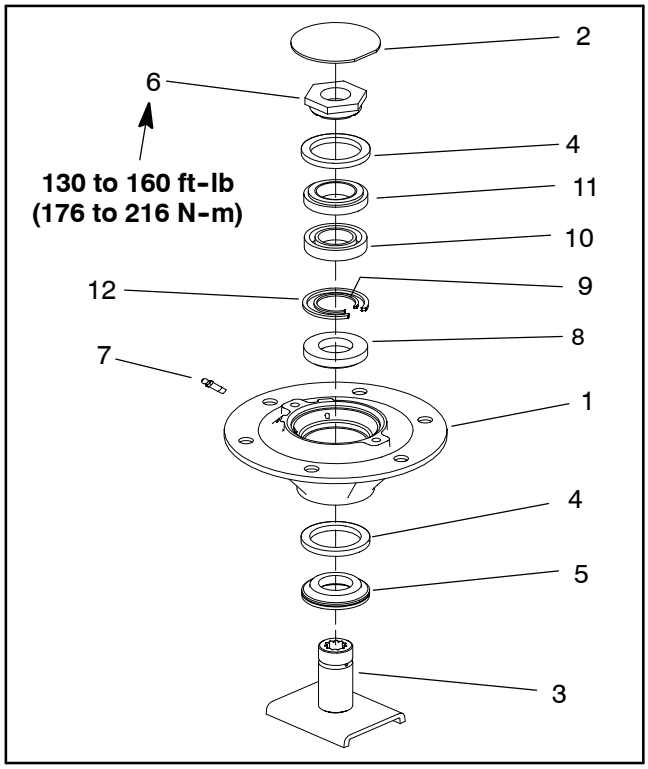

Figure 15

1. **Spindle housing**
2. **Spindle plug**
3. **Spindle shaft**
4. **Oil seal**
5. **Shaft spacer**
6. **Spindle nut**
7. **Grease fitting**
8. **Bearing**
9. **Spacer ring**
10. **Spacer set (2 piece)**
11. **Bearing**
12. **Large snap ring**

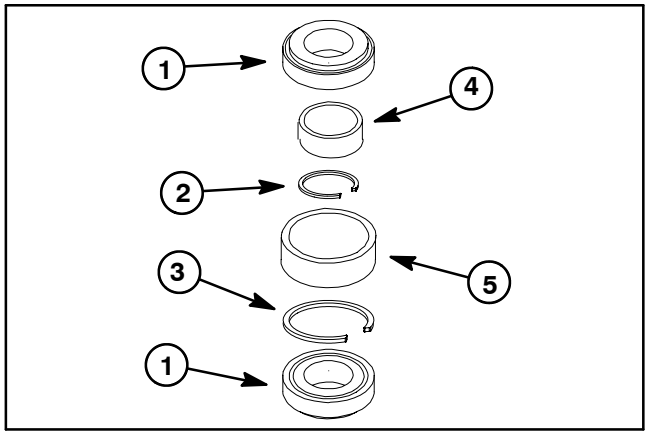

Figure 16

1. **Bearing**
2. **Spacer ring**
3. **Large snap ring**
4. **Inner spacer**
5. **Outer spacer**

4. Pack the bearing cones with grease. Apply a film of grease on lips of seals.

5. Install lower bearing and seal into bottom of spindle housing. **Note:** The bottom seal must have the lip facing out (down) (Fig. 18).

6. Slide spacer ring and inside spacer into spindle housing, then install upper bearing and seal into top of housing. **Note:** The upper seal must have the lip facing out (up) (Fig. 18).

7. Inspect the spindle shaft to make sure it is free of burrs or nicks that could possibly damage the seals. Also, make sure that lubrication hole in shaft is clean. Lubricate the shaft with grease.

8. Install spindle spacer onto shaft. Carefully slide spindle shaft through spindle housing. The bottom seal and spindle spacer will fit together when the spindle is installed fully.

9. Thread spindle nut onto shaft and tighten nut from 130 to 160 ft–lb (176 to 216 N–m).

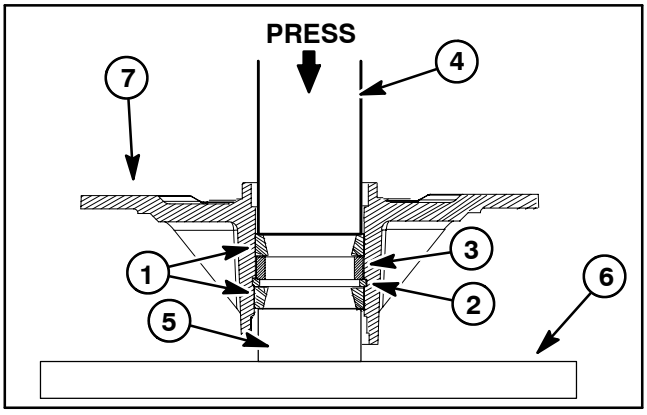

Figure 17

1. **Bearing cups**
2. **Large snap ring**
3. **Large spacer**
4. **Arbor press**
5. **Support**
6. **Arbor press base**
7. **Spindle housing**

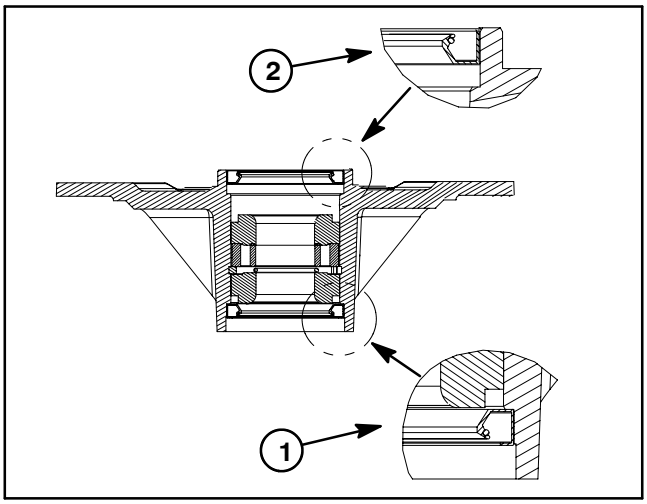

Figure 18

1. **Bottom seal installation**
2. **Upper seal installation**

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Chapter 8

Electrical Diagrams

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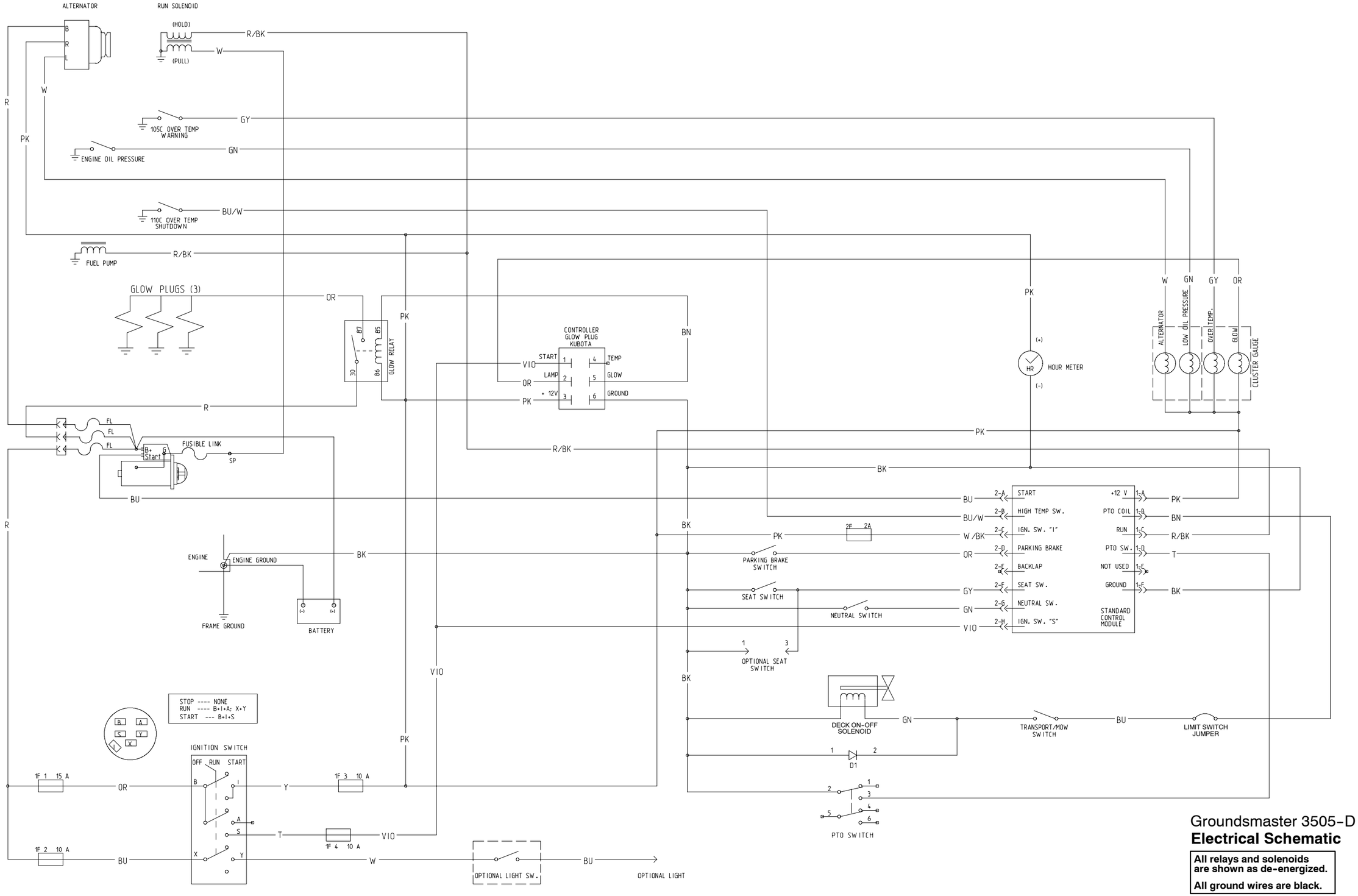
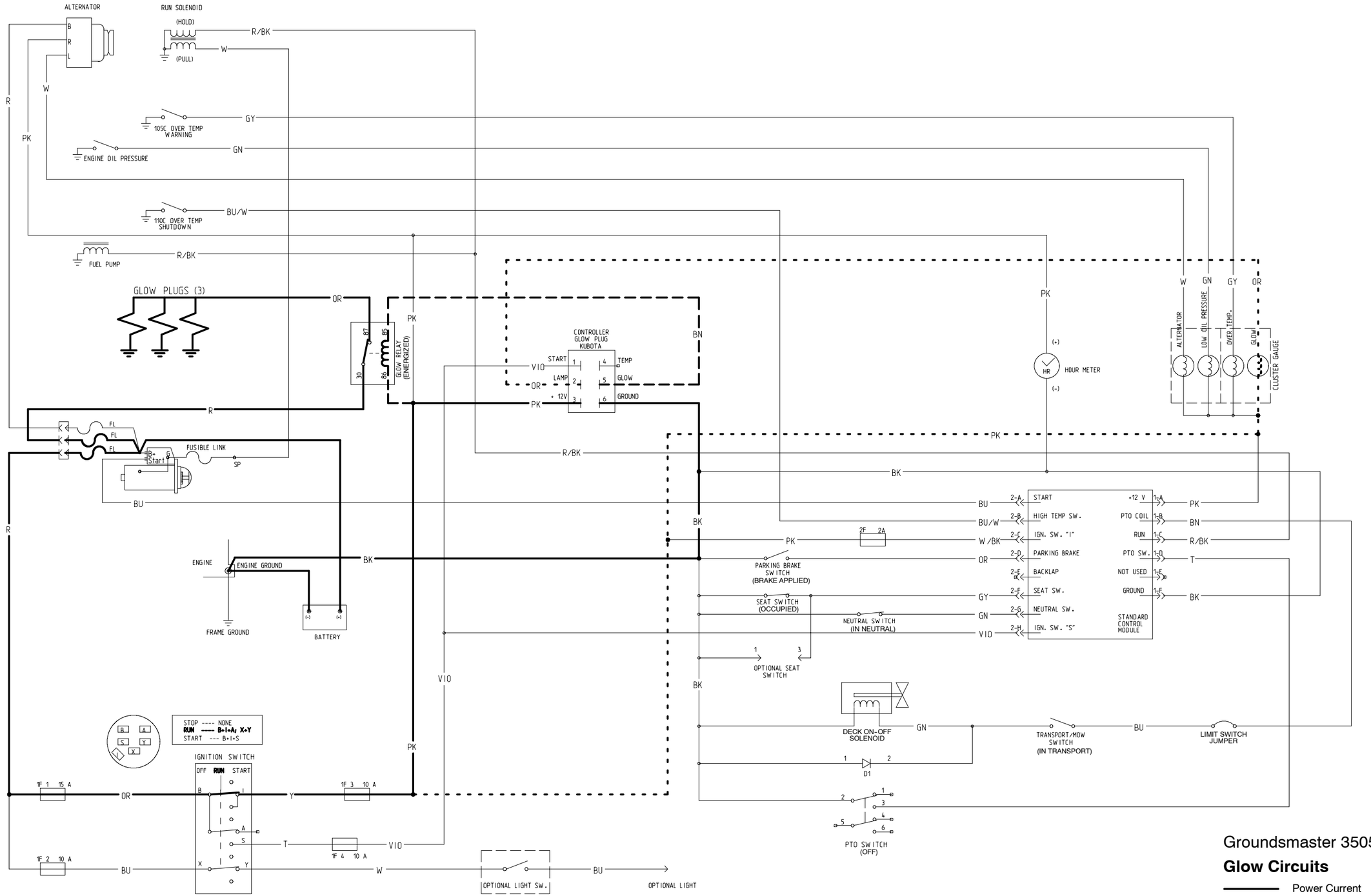


Groundsmaster 3505-D

Electrical Schematic

All relays and solenoids are shown as de-energized.

All ground wires are black.



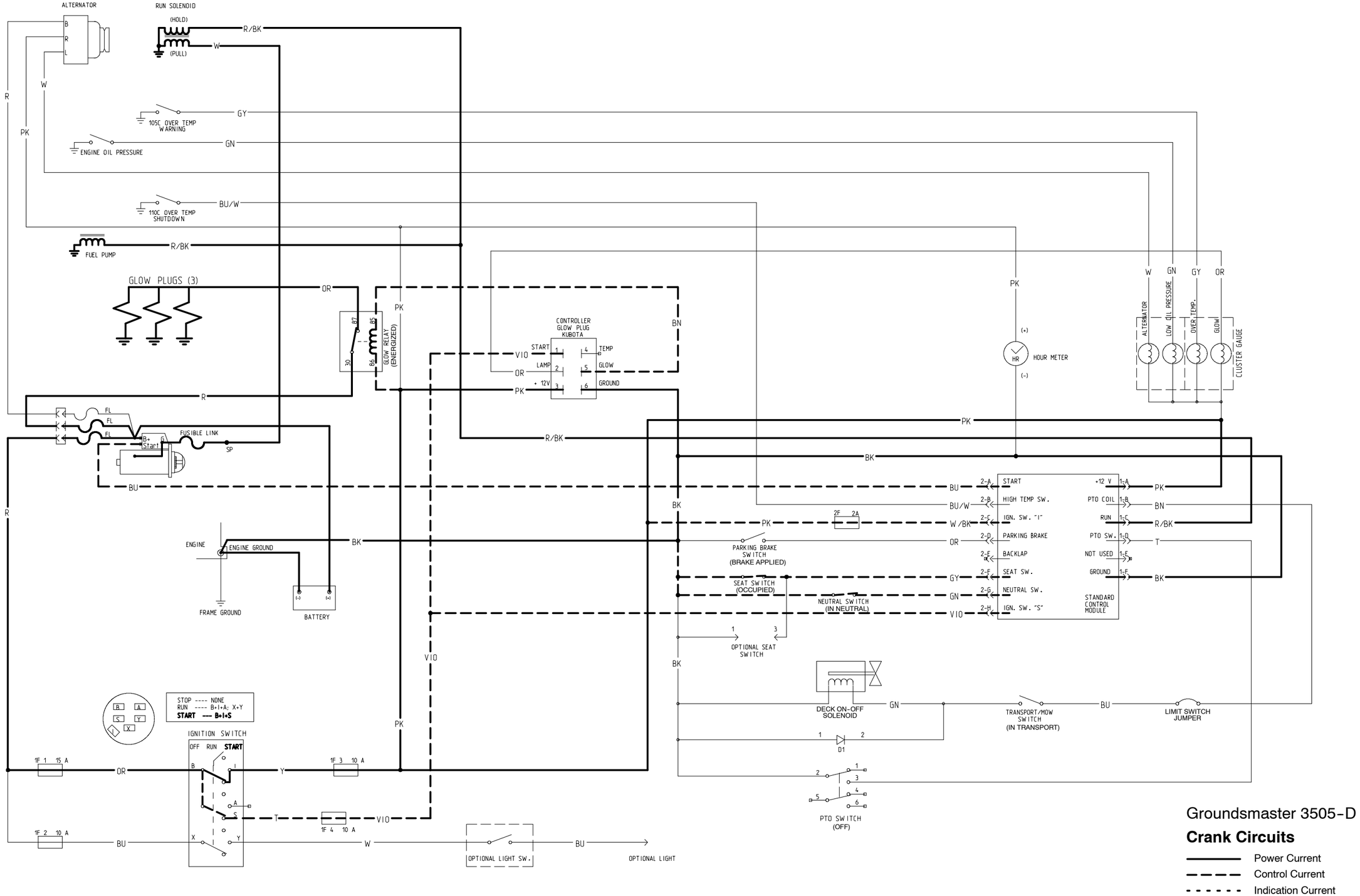
Groundsmaster 3505-D

Glow Circuits

Power Current

Control Current

Indication Current



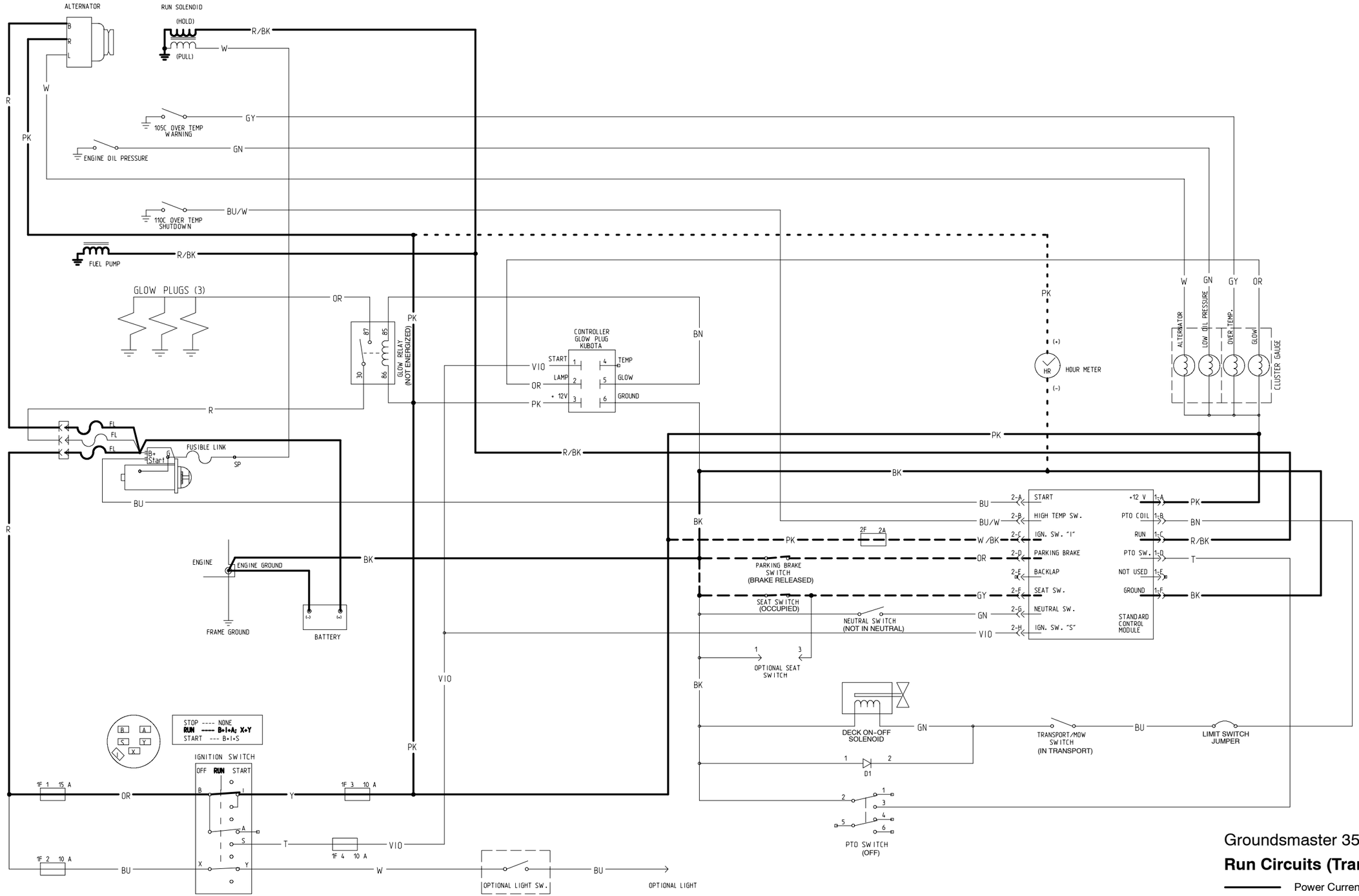
Groundsmaster 3505-D

Crank Circuits

Power Current

Control Current

Indication Current



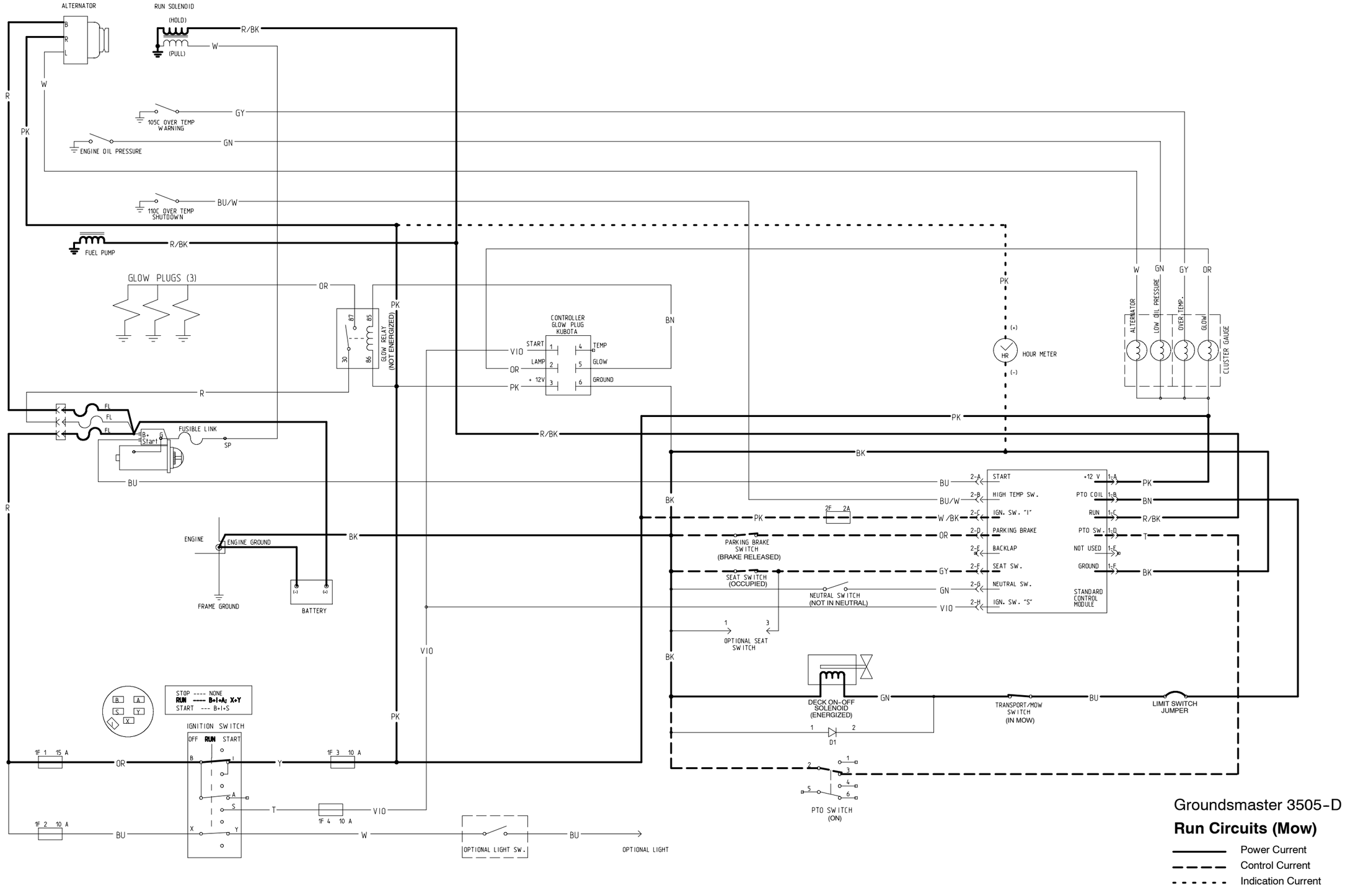
Groundsmaster 3505-D

Run Circuits (Transport)

Power Current

Control Current

Indication Current



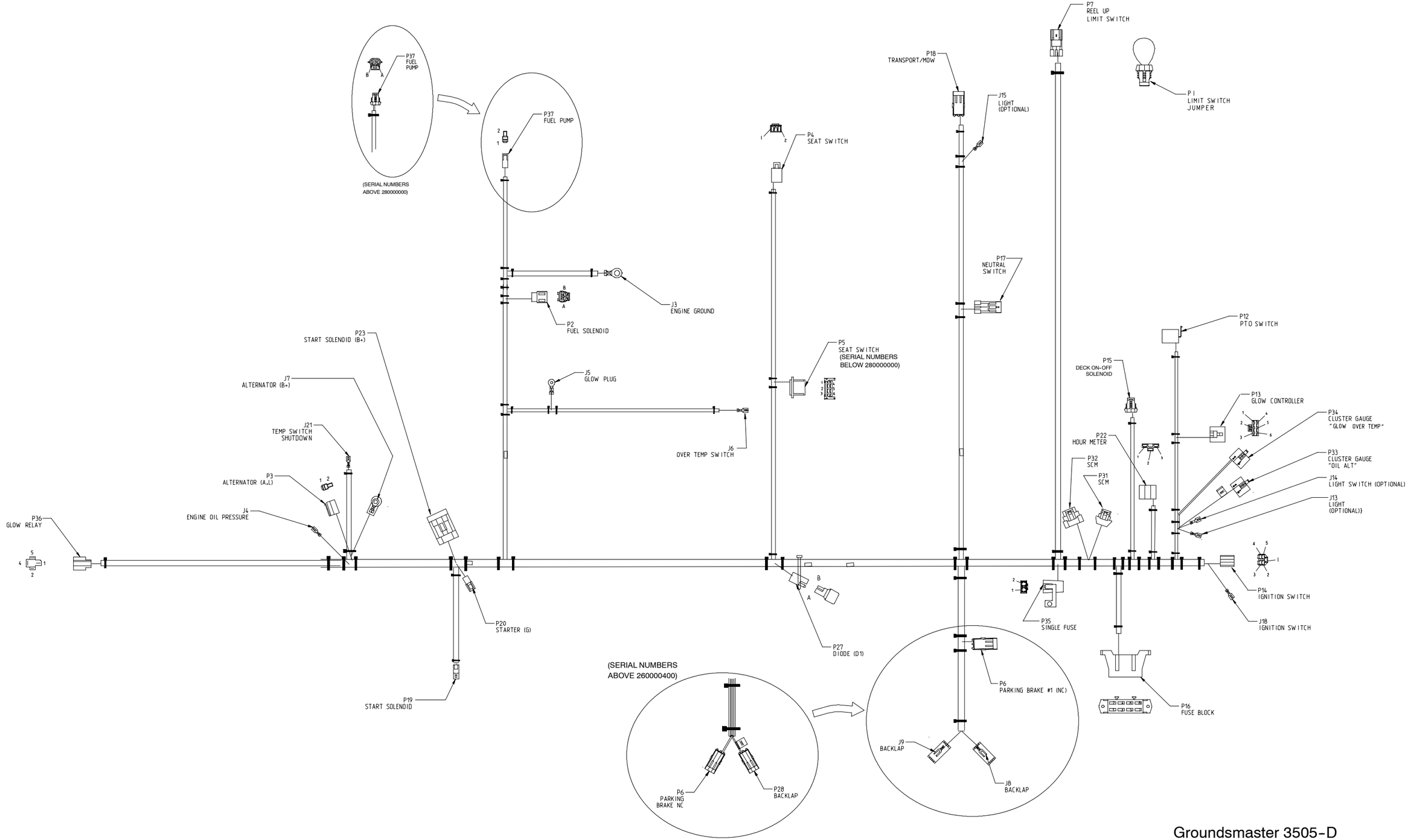
Groundsmaster 3505-D

Run Circuits (Mow)

Power Current

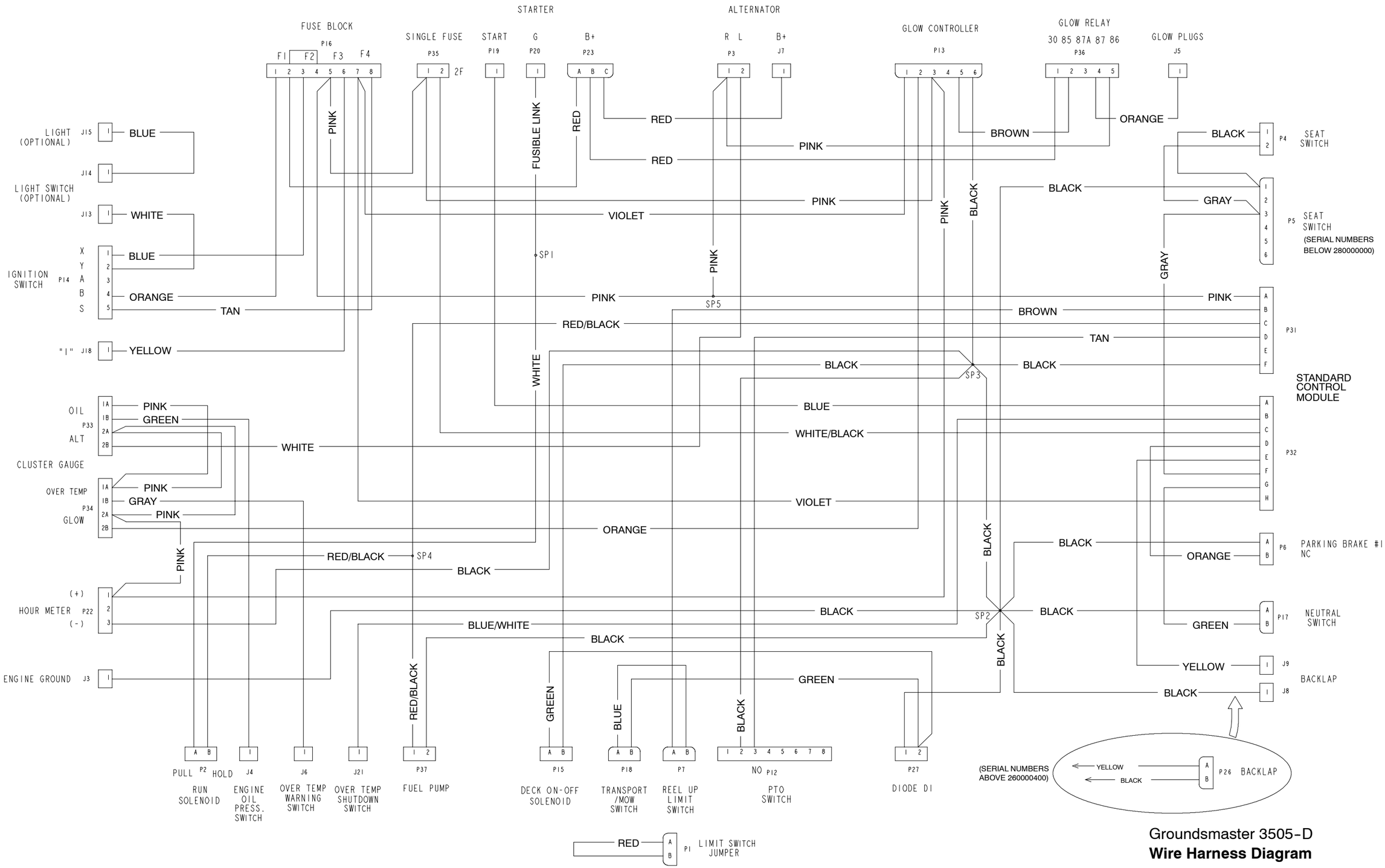
Control Current

Indication Current



Groundsmaster 3505-D

Wire Harness Drawing



Groundsmaster 3505-D
Wire Harness Diagram

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